Technology, Public Policy, and the Changing Structure of American Agriculture

Volume II—Background Papers

Part B: Economics and Policy Analysis

1. Farm Commodity Policy, Technological Advance and Structural Change
2. Size Economies and Comparative Advantage in the Production of Corn, Soybeans, Wheat, Rice, and Cotton in Various Areas of the United States
3. Economic Impacts of Selected Policies and Technology on the Economic Viability of Three Representative Cotton Farms in the Texas Southern High Plains
4. Economic Impacts of Selected Policies and Technology on the Economic Viability of Three Representative Wheat Farms in the High Plains
5. Economic Impacts of Selected Farm Policies, Income Tax Provisions, and Production Technology on the Economic Viability of Corn—Soybean Farms in East Central Illinois and Irrigated Row Crop Farms in South Central Nebraska
6. Economic Effects of Selected Policies and Technology on the Economic Viability of General Crops Farms in the Delta Region of Mississippi
7. Economic, Policy, and Technology Factors Affecting Herd Size and Regional Location of U.S. Milk Production

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Paper No.

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2. Size Economies and Comparative Advantage in the Production of Corn, Soybeans, Wheat, Rice, and Cotton in Various Areas of the United States by Stephen C. Cooke
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6. Economic Effects of Selected Policies and Technology on the Economic Viability of General Crops Farms in the Delta Region of Mississippi by B.R. Eddleman, J.A. Musick, and J.G. Hamill
7. Economic, Policy, and Technology Factors Affecting Herd Size and Regional Location of U.S. Milk Production by Boyd M. Buxton

Background Paper No. 1

Farm Commodity Policy, Technological Advance and Structural Change

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March 1983

Office of Technology Assessment
U.S. Congress

This background paper was prepared for the assessment "Technology, Public Policy, and the Changing Structure of American Agriculture." The views expressed are those of the author(s) and not necessarily those of OTA.

Farm Commodity Policy, Technological Advance and Structural Change*

Commodity programs have been developed and executed over the years with the objective of raising farm incomes. These programs have involved the use of non-recourse loans, government purchases, storage operations, acreage controls, marketing quotas, marketing orders and a variety of commodity disposal operations. There is widespread agreement that these programs, in the short-run, held farm incomes above what they otherwise would have been; there is much less agreement about the long-run income effects of the commodity programs. But in periods of general farm surpluses and excess production capacity the commodity programs have served to put a floor under commodity prices, and thus had the effect of stabilizing farm prices. In the long period 1953-1970 in which American agriculture suffered from chronic excess production capacity, the commodity programs acted to stabilize farm commodity prices, as those prices rode on the supporting mechanisms of the commodity programs (e.g. on the non-recourse loan levels). Thus, it is the thesis of this paper that the price stablizing actions of the commodity programs in conjunction with farm technological advance operated to change the structure of farming---operated to concentrate farm productive resources into fewer and fewer hands. But commodity policy did not do this by magic or through some kind of transcendental logic. The reasoning by which structural change occurred in American farming as the result of commodity policy thus must be a central feature of this paper.

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*A paper presented before an OTA workshop in Washington, D.C., March 23-24, 1983, by Willard W. Cochrane, Professor Emeritus, University of Minnesota.

But first one important caveat. Commodity policy was not the only force operating to effect structural change in American agriculture. And commodity policy could play the role that it did only where certain preconditions were met by the social infrastructure and government. I would list at least four essential preconditions:

1. A flow of new and improved technologies to farmers in forms that could be readily adopted by them
2. A literate, educated set of farm operators who could understand both the economic and technical implications of those technologies
3. A credit system, public and private, that could assist farmers to acquire those technologies and
4. A government which protected the property rights of its citizens and permitted them to benefit from, or profit from, their innovative productive acts.

* * * * * * *

How do commodity programs via farm technological advance actually influence structural change in farming? The reasoning runs as follows. Farmers are price takers. No one farmer in the major commodities can significantly influence supply, hence influence the price which he receives. But the individual farmer can do something about his operating costs. An innovative farmer can adopt a new and improved technology which raises his production function and lowers his firm's cost structure. Since price is not effected, the innovative farmer reaps a profit by this adoption. It is also the case that as his cost structure falls, the farmer increases his output at the given price as he expands along his new and more productive marginal cost curve. Other farmers follow this innovator, the adoption of the new and improved technology becomes widespread, aggregate supply increases and the price of the product declines. After a period of adjustment a new equilibrium is reached at a lower price in which the innovator is back in a no profit situation. This is the classic Treadmill in operation in a free market.

It is possible that the innovative farmer used some of his profits to buy up the assets of his less efficient neighbors, and thus began to change the structure of farming. How much of this would go on in the free market situation would depend upon the state of knowledge among farmers and the speed at which the adoption of the new technology took place. But certainly the development process in a free market situation would exhibit some tendency to concentrate resources in the hands of the aggressive, innovative farmers.

Now assume the operation of a commodity program in which the price of the commodity is supported at the long-run equilibrium price, or at some higher level. The individual farmer still cannot influence the price which he receives for his product. But he can take actions to reduce his costs. This he can do by adopting a new and improved technology. The adoption of the new technology raises his production function and lowers his cost structure. As a result he reaps a profit for his innovative act and he increases his output along his new and more productive marginal cost curve. Other farmers follow the lead of our innovative farmer. This results in an increase in aggregate supply. But this time the price does not fall. The product price is supported by government action. Now each of the early adopters seeks to expand his output by acquiring the assets of his less able neighbors. And each of the early adopters, perhaps 10 to 20 percent of the farm population, can achieve his expansion objective if he experiences constant returns to size, [1] or moves along a flat long-run planning curve. This appears to have been the case over the relevant ranges of farm expansion in the past 30 years. So farm technological advance with government supported product prices results in structural change in which productive assets in farming are concentrated in the hands of aggressive, innovative farmers. But the total amount of arable land is limited, hence competition for this land among the innovative farmers, some of whom are also car dealers, medical doctors and local bankers, causes the price of land to rise. After a period of adjustment a new equilibrium is reached in which the expanded, aggressive, innovative farmer-businessmen are back in a no profit situation. Only in this case the equilibrium is reached by a rise in land values rather than through a fall in product prices. This is the Treadmill with producer Cannibalism under government price support programs. And the argument does not change with income payments where those payments are linked to the volume of product.

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[1] I use the term "return to size" rather than "return to scale" because I believe true increases in scale are possible to achieve. Management remains constant at one and management is a nonhomogenous factor.

The basic notions behind this line of reasoning were first presented in English by Joseph Schumpeter in his book The Theory of Economic Development, Harvard University Press, 1936. I adapted those notions to the agricultural economy in my volume Farm Prices: Myth and Reality, University of Minnesota Press, 1958. I expanded the analysis to take account of the farm commodity programs in my book The Development of American Agriculture: A Historical Analysis, University of Minnesota Press, 1979.

Any technological advance that lowers the cost structure of the farm firm must result in an expansion in supply by the firm involved, if price holds constant. The geometry of the cost structure forces that conclusion. But it seems reasonable that some technological developments would more readily facilitate the movement along the long-run planning, or cost, curve of the firm than others. In fact, certain farm technological advances must have resulted in a declining long-run planning, or cost, curve over wide reaches of firm output. The mechanical inventions that involved, first, the shift from human power to horse power and, second, from horse power to tractor power are a dramatic case in point. Technological advances in veterinary medicine that made preventive medicine a practicality in poultry and hog production is another case in point. And technical advances in the use of chemicals in controlling weeds and other pests is another case in point. The adoption of the above new and improved technologies not only reduced cost structures in the short-run but it permitted innovative farm operators to move out along a flat to declining long-run planning, or cost, structure. As a result these types of farm technological advances must have contributed to an increased concentration of productive resources in farming, with or without government intervention.

Farm technological advances also often came in clusters. This was the case with hybrid seed corn. The farm operator reaped the full benefit from the adoption of hybrid seed corn only to the extent that he increased the number of plants per acre, increased the applications of chemical fertilizer, employed the new chemical weed and pest killers and adopted new and improved planting and harvesting equipment. By adopting the full cluster of related technologies the farmer is able to not only reduce his costs in the short-run but to expand along his planning curve in the long-run.

The point to all this is that any technological advance, by definition, reduces the structure of costs in the short-run, but only certain types of technological advances will facilitate an expansion along the long-run planning curve of the firm.

* * * * * * *

The authors of the report A Time to Choose conclude that commodity programs have "fostered the continued growth in the size of farm firms----." They do not provide any logical explanations as to how the commodity programs have contributed to the increased concentration of farm productive resources into the hands of fewer and fewer farmers. They argue, and correctly so, that the distribution of benefits of the commodity programs have been skewed in the direction of the large producers. And they imply that such a skewed distribution of program benefits has helped the large producers to become larger, which is probably correct. But such an explanation begs the central question. How did the large producers become large in the first place? To this question the authors of A Time to Choose provide nothing in the way of an answer.

Further, and most important for this discussion, the authors of A Time to Choose do not link farm technological advance to commodity policy in dealing with the issue of structural change. Commodity policy is discussed in some depth in one chapter of that title and farm technological advance is handled in a cursory way in two other chapters: one dealing with public research and the other presenting "A Profile of American Agriculture." A logical discussion of the relationships among the categories (1) commodity policy, (2) farm technological advance and (3) structural change simply does not emerge in A Time to Choose.

The two best studies, of which I am aware, of the influence of commodity policy on farm technological advance and farm productivity are both relatively old. They bare mentioning in this context because both demonstrate the dramatic influence of price stability and price assurance in inducing farmers to adopt new and improved technologies and in increasing farm productivity. Those studies are: (1) An Economic Analysis of the Impact of Government Programs on the Potato Industry of the United States[2] by Roger W. Gray, Vernon L. Sorenson and Willard W. Cochrane and (2) Burley Tobacco Control Programs[3] by Glenn L. Johnson.

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[2] University of Minnesota Agric. Exp. Sta. Tech. Bul. 211, June, 1954

[3] University of Kentucky Agric. Exp. Sta. Bul. 580, Feb., 1952

The Minnesota potato study shows clearly that it was not a high level of price support that stimulated potato production in the late 1940's; rather it was the introduction of price stability via the government potato program which: (1) induced farmers to adopt a cluster of new and improved technologies (2) thereby greatly increasing potato yields per acre and (3) as a result greatly increasing specialization in the production of potatoes as well as total output. But neither the potato study nor the tobacco study deal with the issue of structural change. Structural change was not an issue in the early 1950's.

In sum, then, I have no additions to, or modifications to, the theory dealing with commodity policy, technological advance and structural change outlined in the second section of this paper.

* * * * * * *

The theory developing the relationships among categories (1) commodity policy, (2) technological advance and (3) structural change is useful and relevant as far as it goes. It does not go far enough, however, to enable us to deal competently with the structural change issue. Our knowledge needs to be expanded in certain areas if we are to fully understand the impact of commodity programs on the structure of agriculture in the development process and to take wise policy actions in this area. In this paper we will consider three areas where our knowledge is short and our need is great.

First, we know that price stability operates to induce farmers to adopt new and improved technologies. And logic suggests that the higher the level at which product prices are stabilized, the more rapid and widespread will be technological advance in farming. But it does not follow from this that high and stable product prices necessarily speeds the cannibalistic process and resource concentration in farming. The high and stable prices may help the weak and inefficient to stay in business. In short we do not know how different levels of price and income support impact on the rate of resource concentration in farming. Our theory is silent on this question, although at least two hypotheses that move in opposite directions are possible. And there are no empirical data that bear on this question to my knowledge.

So the question arises, if we want to slow the process in which productive resources in farming are concentrated in fewer and fewer hands, should we seek to support and stabilize product prices at low levels, or at high levels, or somewhere in between?

Second, a critical area of ignorance relates to the configuration of the long-run planning, or cost, curve for the farm firm. It has been hypothesized for some time that the long-run planning curve is flat over a wide range of farm firm output, hence, the aggressive, innovative farm operator has found it easy to expand his operations along a curve that reflects constant returns to size. If this is the case, and if the planning curve remains flat over a greatly expanded range of output, then we must expect the concentration of farm productive resources to continue with great force. But if the long-run planning curve for our larger farms is already beginning to turn up, then we should expect the process of resource concentration to slow down, and for policy actions designed to accomplish that objective to be effective.

We are almost totally ignorant regarding the shape of the long-run planning, or cost, curve at very large volumes of output. Thus, we don't know whether we are working with an economic force that is so powerful that there is little or no possibility of controlling it with public policies, or whether the force has largely expended itself and with some intelligent policy actions we could slow the process of resource concentration in farming to a walk.

Third, we are spending a lot of money on scientific inquiry and technological development in agriculture, and the scientific community may have a pretty good idea of what is going on in this area. But the policy makers of the nation and their advisors have little knowledge regarding the state of technological development: which technological developments have run their course through widespread adoptions, which are just coming over the horizon and may have an important influence on farm productivity in the near future,and which developments are a long way off in terms of farm adoption.

What we need is a technological inventory in agriculture about every five years which tells the policy makers what to expect in the way of farm technological advance during the coming five years. As it is now, farm policy makers and their advisors are flying blind. Technologically speaking we have a pretty good idea what happened in farming five years after the fact, but for the next, or coming, five years we do little more than project what happened in the past five years. We can and should do better than that.

* * * * * * *

The research approach for producing a useful inventory of farm technological development need not be complex. It will involve the collection, refinement and presentation of primary data dealing with technological developments. The survey work involved in the collection of that data is, however, likely to prove costly since the data to be collected are likely to be heterogenous in the extreme. Some careful presurvey work would be essential to formulate categories of technological development which would turn out to be useful to policy makers as well as scholars. I have reference here to categories that would be informative with respect to states of development. Further, there would need to be people associated with the project that could provide reasonable estimates of the speed at which fully developed technologies might be adopted by farmers as well as estimates of the effects of such adoptions on farm productivity and increases in farm output.

The research approach under consideration is not conceptually difficult. But it would be costly. The new information on farm technological prospects should, however, be worth the costs.

Eliminating the state of ignorance with respect to the shape and extent of the long-run planning, or cost, curve will constitute a more difficult task than that concerned with farm technological prospects. But it is not an impossible task. I would recommend an engineering approach in this area in which all the relevant input-out relationships are specified for a particular type of farm at the existing state of technology. Then this representative farm would be "operated" via the computer at varying levels of output with different fixed asset combinations.

There are, of course, many problems associated with this approach. How is management to be treated; is it held constant at one or is it assumed to be perfectly divisible? Judgements will have to be made regarding the fixed asset combinations, particularly at very large volumes of farm output. New input-output relationships would have to be established on the basis of experience and engineering studies. But engineering studies such as are envisaged here should produce the input-output data over wide ranges of output from which meaningful long-run planning, or cost, curves could be constructed for different types of farms. From such studies we should gain an understanding of the power of the economic forces pushing in the direction of increased resource concentration in American agriculture.

The last area of research--that concerned with the effect of different levels of price and income support on resource concentration--is likely to prove the most intractable. In an ideal research world we could simply set price and income support at different levels and then observe what happened to the concentration of resources in farming. But this is impractical for at least two reasons: (1) the federal government cannot experiment with the incomes and lives of real people and (2) many years would be required to observe and measure the full impact of a given level of price or income support on the concentration of resources in a particular commodity area.

Next, asking farmers hypothetical questions regarding farm expansion or farm discontinuance at a given level of price or income support is most likely to produce either superficial or incorrect answers. The large, aggressive, innovative farmer is not going to divulge his true strategy. The farmer about to go-out-of-business will be so confused and so angry that his responses will tend to be wild and incoherent. In short, nothing useful is likely to be learned from a question and answer approach.

Something useful, however, might be learned from the following approach. At least the relevant economic tendencies could be identified via this approach. So what is it? It is the construction of cost structures of different sized farms at different states of technological advance for a given type of farming area. Depending upon how varied a set of farm cost structures were constructed for a given type of farming area, it might be necessary to collect some new and additional input-output data. But this research approach could certainly get underway with the vast amount of production data now in existence in the colleges and the U.S.D.A.

Once the relevant set of cost structures were established for each type of farming area and estimates were made with respect to the number of farms falling in each cost structure class, then informal judgements could be made regarding the number of farms that should be making a profit at a given level of price and income support and the number whose unit costs exceed the level of support. This is not an easy approach. It will involve the making of judgements regarding farm classes. It is likely to involve the collection of some new data. It may well involve asking some new questions in the Agricultural Census. But if I were the Assistant Secretary for Economics in the Department of Agriculture I would be pushing hard on ERS to undertake research along these lines.

Background Paper No. 2

Size Economies and Comparative Advantage in the Production of Corn, Soybeans, Wheat, Rice, and Cotton in Various Areas of the United States

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CHAPTER I

INTRODUCTION AND EXECUTIVE SUMMARY

Willard Cochrane, in a recent paper written for the Office of Technology Assessment, states his concern over resource concentration in American agriculture and our ignorance about the process of resource concentration. For example, Cochrane states that "we are almost totally ignorant regarding the shape of the long-run planning, or cost curve, at very large volumes of output. Thus, we don't know whether we are working with an economic force that is so powerful that there is little or no possibility of controlling it with public policies, or whether the force has largely expended itself and with some intelligent policy actions we could slow the process of resource concentration to a walk" (Cochrane, 1983. p. 8).

This paper is an attempt to address this gap in our knowledge of size economies and comparative advantage in the production of corn, soybeans, wheat, rice and cotton within and between some of the major producing areas for these commodities in the United States. The intent of this study is to provide an overview of the variation in cost of production by enterprise size and geographic location and information on the sources of variation in production costs for these five commodities.1/ This study should improve understanding of the

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1/ The cost data presented and analyzed are for 1979 for rice, for 1982 for cotton and for 1983 for corn, soybeans and wheat.

process of resource concentration in American field crops, particularly as it relates to size economies and comparative advantage.

1.1 Size Economies

The concept of economies of size is defined as the relationship between enterprise size (measured in acres) in combination with other productive services and the rate of output of the enterprise (Stigler, 1958, p. 54). This relationship is measured in terms of cost per unit of output. Three enterprise size categories are used in this study: very large, large and medium. Arranging enterprises within a production area in decreasing order by planted acreage, very large enterprises are those enterprises in the 90th decile. Large enterprises comprise the 70th and 80th deciles and medium enterprises comprise the 40th through 60th deciles. The evidence for size economies is based on four measures: the Herfindahl concentration index, the change in the Herfindahl index over time, extent of utilization of harvesting machinery, and production cost by enterprise size. The geographic location of the selected producing areas for the five field crops is presented in Figure 1. These production areas have been designated by USDA on the basis of soil types, climatic conditions and type of farming systems.

The data suggest the following conclusions or hypotheses regarding size economies. See Table 1. Given the enterprise configuration for these commodities in the selected areas, size economies exist in the production of corn, as very large enterprises on average have a 4 to 11% cost advantage over large and medium enterprises. The long-run cost curves for soybeans, wheat, and cotton appear on average to be rather flat across enterprise sizes in the selected producing

Figure 1.

FIRM ENTERPRISE DATA SYSTEM
Production Areas

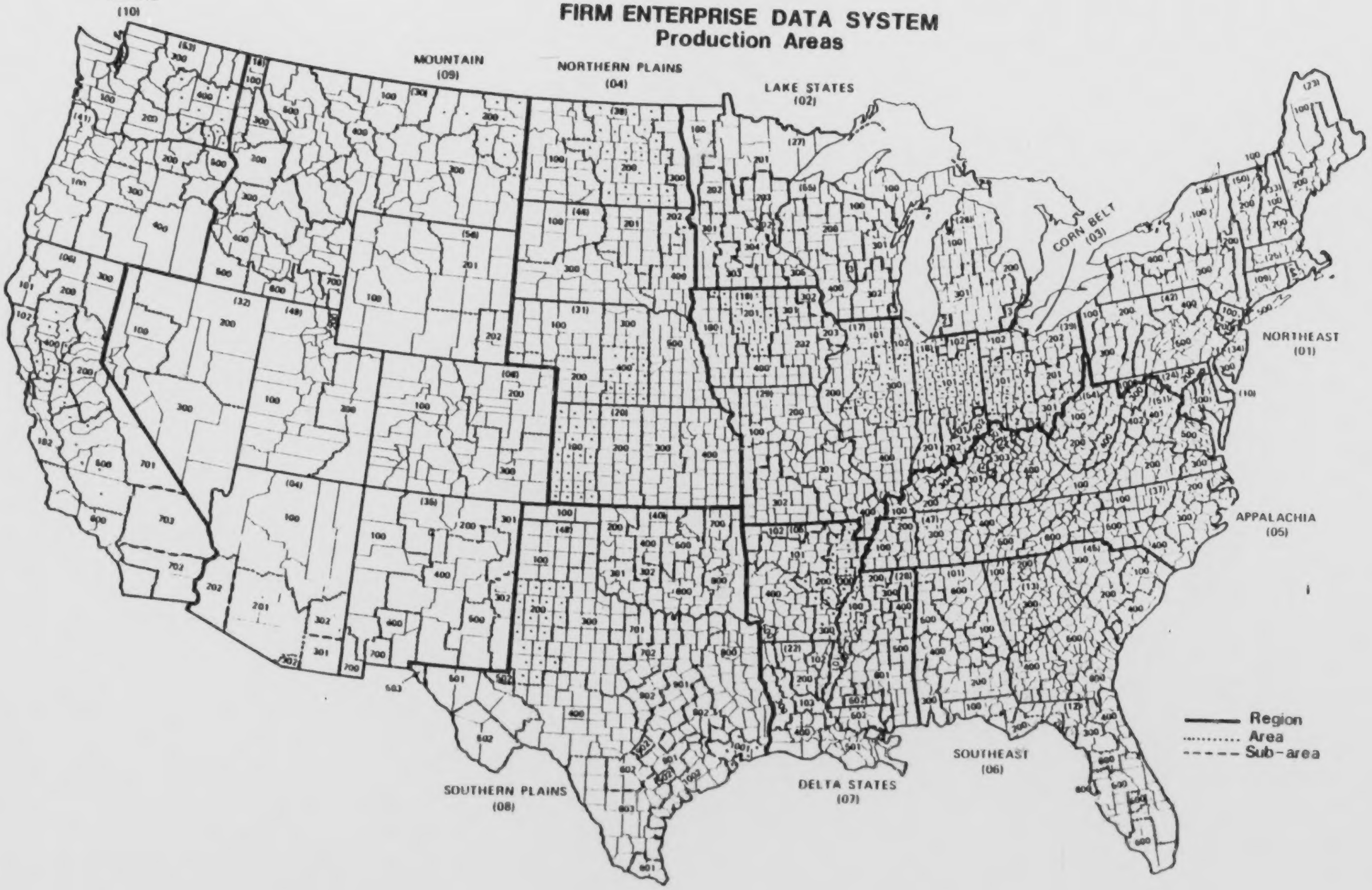

PACIFIC (10)
MOUNTAIN (09)
NORTHERN PLAINS (04)
LAKE STATES (02)
CORN BELT (03)
NORTHEAST (01)
APPALACHIA (05)
SOUTHEAST (06)
DELTA STATES (07)
SOUTHERN PLAINS (08)
Region
Area
Sub-area

Table 1. A Summary of Economies of Size in the Production of Corn, Soybeans, Wheat, Rice and Cotton in Selected Areas of the U.S.

Evidence Indicates	Corn 1/ State/Area	Soybeans 1/ State/Area	Wheat 1/ State/Area	Rice 2/ State/Area	Cotton 3/ State/Area
Clear Advantage for Very Large Enterprises	IL 300 IO 201 NE 400*		MT 200		AL 600 TX 200
Clear Advantage for Very Large and/or Large Enterprises	IN 101	IL 300 IO 201 OH 101	KS 100 ND 200		CA 500* TX 200*
No Obvious Advantage for Any Enterprise Size		MS 100	WA 400	CA 400* TX 1001* DLT 100-300* AK 200*	MS 100
wt. ave. 4/	4 to 11%	-2 to 0%	7 to 3%	-2 to -4%	-3 to 0%

1/ Based on 1983 data. 2/ Based on 1979 data. 3/ Based on 1982 data. * Irrigated.

4/ Size economies based on the ratio of average production costs for large and medium enterprises to very large enterprises respectively.

areas. For soybeans, very large enterprises on average have no significant advantage (-2 to 0%) relative to large and medium enterprises. This also appears to be the situation for cotton. For wheat, very large enterprises on average have only a 3% cost advantage over medium enterprises. Size diseconomies appear to exist on average in the production of rice in the selected areas in 1979. Very large rice enterprises have a small but consistent cost disadvantage (-2 to -4%) relative to large and medium enterprises in the areas studied.

1.2 Comparative Advantage

Comparative advantage refers to the relationship between production possibilities and commodity prices among locations with different initial resource endowments. Enterprises then ". . . operate at points on their respective production possibilities frontiers at which their rates of product transformation are equal." (Nicholson, 1972, pp. 415-416). For simplicity, we determine comparative advantage by assuming linear production possibilities curves and constant commodity price ratios (Heady, 1952, pp. 655-662). None-the-less producers in different areas, producing the same commodity with different initial resource endowments must attempt to maintain nearly similar average total production costs in order to remain competitive. Conversely, producers in different areas with average cost above a "normal" range in variation will lose market share, will not cover production costs and eventually will go out of production.

In this study, comparative advantage is based on the weighted average of production costs for the representative very large, large and medium enterprises compared across producing areas for a given commodity. Production costs include preharvest and harvest variable costs including hired and family labor costs, and ownership costs including capital ownership costs, general farm overhead and a land charge. A five-year average yield is used to minimize effects of atypical production conditions. Management is assumed to be the residual claimant in the production process. The production process associated with one crop is called an enterprise. For the purposes of this study we are assuming that the enterprise efficiency is an appropriate indicator of the productive efficiency for the farm as a whole (see Section 8.8).

The data including trends in yield and land prices suggest the following hypotheses or tentative conclusions regarding comparative advantage. See Table 2. Assuming a 10% return to land, Iowa area 201 has a comparative advantage in corn and soybean production relative to the other production areas included in this study. Illinois area 300 may overtake Iowa area 201 in terms of comparative advantage in soybean production in the future. Mississippi area 100 is a marginal soybean producing area. A marginal area is defined here as one in which it is at least 20% more expensive to produce a given unit of output for that commodity as compared to the least-cost area. Among the areas studied, Kansas area 100 and Washington area 400 have about equal comparative advantage in the production of wheat. In terms of maintaining comparative advantage, size economies in wheat production tend to favor Kansas area 100 while the trends in relative yields and land values tend to favor Washington area 400. California area 400 has a comparative advantage in short and medium grain rice production. If the trends in relative yields and land values continue, California area 400 will maintain its comparative advantage in the future. Texas

Table 2. Comparative Advantage in the Production of Corn, Soybeans, Wheat, Rice and Cotton in the Selected Producing Areas, Assuming a 10% Return on Land Investment.

Corn 1/		Soybeans 1/		Wheat 1/		Rice 2/		Cotton 3/	
State & Area	Com. Adv. 4/ %	State & Area	Com. Adv. 4/ %	State & Area	Com. Adv. 4/ %	State & Area	Com. Adv. 4/ %	State & Area	Com. Adv. 4/ %
IO 201	100	IO 201	100	KS 100	100	CA 400*	100	MS 100	100
NE 400*	108	IL 300	103	WA 400	100	AK 200*	108	TX 200*	101
IN 101	110	OH 101	105	MT 200	103	DLT 100-300*	114	TX 200	104
IL 300	114	MS 100	124	ND 200	109	TX 1001*	124	CA 500*	109
								AL 600	123

1/ 1983 data. 2/ 1979 data. 3/ 1982 data. * Irrigated.

4/ Comparative advantage based on average production costs assuming a 10% return on 1982 land values for corn, soybeans, wheat and cotton and on 1978 land values for rice and indicated by the percent over the lowest cost production area (with a value of 100%). Also assumes constant marginal rates of product substitution and constant commodity price ratios.

area 1001 is a marginal long grain rice producing area. Finally, Mississippi area 100 and Texas area 200 have nearly equal comparative advantages in cotton production. The trends in relative yields and land prices indicate that Mississippi area 100 will maintain its competitive position in the future as well. Texas area 200 (dryland) has the advantage of unexploited size economies, though this is offset by a decrease in relative yield which may result in a decline in comparative advantage relative to Mississippi area 100. Alabama area 600 is a marginal cotton producing area.

Assuming a 5% return to land, Nebraska area 400 corn, North Dakota area 200 wheat and the Delta areas 100 and 300 rice also become marginal producing areas. See Table 3. The reason for this is that land is the single most costly input in the production of all five commodities. Utilization of a lower rate of return on land effectively discounts the source of comparative advantage in areas with relatively low land prices.

1.3 Size Economies and Comparative Advantage

The data suggest the following hypotheses regarding the relationship between size economies and comparative advantage. See Table 2. There is evidence that areas with comparative advantage such as Iowa area 201 for corn and soybeans and Kansas area 100 for wheat have unexploited size economies. Ceteris paribus this implies that enterprises in these areas are not operating at the minimum-cost point on their production possibilities frontier. Conversely areas with substantial (actual or potential) comparative disadvantage, such as Nebraska area 400 for irrigated corn, Mississippi area 100 for soybeans, and Alabama area 600 for cotton, exploit size economies more

Table 3. Comparative Advantage in the Production of Corn, Soybeans, Wheat, Rice and Cotton in the Selected Producing Areas, Assuming a 5% Return on Land Investment.

Corn 1/		Soybeans 1/		Wheat 1/		Rice 2/		Cotton 3/	
State & Area	Com. Adv. 4/ %	State & Area	Com. Adv. 4/ %	State & Area	Com. Adv. 4/ %	State & Area	Com. Adv. 4/ %	State & Area	Com. Adv. 4/ %
IO 201	100	IO 201	100	KS 100	100	CA 400*	100	TX 200	100
IN 101	114	IL 300	102	WA 400	104	AK 200*	114	MS 100	101
IL 300	116	OH 101	109	MT 200	112	DLT 100-300*	120	TX 200*	103
NE 400*	129	MS 100	138	ND 200	133	TX 1001*	134	CA 500*	107
								AL 600	125

1/ 1983 data. 2/ 1979 data. 3/ 1982 data. * Irrigated.

4/ Comparative advantage based on average production costs for all size enterprises combined assuming a 5% return on 1982 land values for corn, soybeans, wheat and cotton and on 1978 land values for rice and indicated by the percent over the lowest cost production area (with a value of 100%). Also assumes constant marginal rates of product substitution and constant commodity price ratios.

fully as a means of remaining competitive in the production of these commodities. Washington area 400 wheat enterprises are an exception having comparative advantage with rather fully exploited size economies.

The results of this study supports both Cochrane's "treadmill" and G.L. Johnson's "overproduction trap" theories. Marginal producing areas in particular are susceptible to the treadmill of technological adoption and the resulting over-production. Marginal producing areas experience decreasing resource values but continue to produce as long as the value of these resources in use is greater than salvage value. Non-marginal areas can avoid the over-production trap by not over-investing in new capital-intensive technology in the first place. Producers in non-marginal areas have the luxury of being less progressive while still remaining competitive. Tweeten is also correct in as much as large firms in marginal areas prevent small firms in non-marginal areas from earning a rate of return to resources comparable to other sectors of the economy. Finally this study supports the idea that new technology has the potential of releasing large tracts of land in selected locations rather than proportional reductions in the required land base spread more-or-less uniforimly across all production areas.

1.4 Organization of the Report

The theory, methodology, data, analysis and conclusions of this study are presented in that order. The theory, methodology and data section begins with a discussion of the theory of size economies and long-run average cost curves. This approach to size economies builds on work by Madden (1967, pp. 24-34). The four measures of size economies which are discussed and used are (1) composite enterprise budgets from actual enterprise surveys in conjunction with a budget generator to estimate cost of production, (2) standardized or adjusted data from actual enterprises to determine the extent of utilization of harvesting machinery, (3) the survivorship technique measured in terms of a static Herfindahl index and (4) a dynamic Herfindahl index. This section also includes a presentation of some of the data used to develop the four indices of size economies. The major sources of data for this study include the Census of Agriculture, Firm Enterprise Data System (FEDS) survey data collected by USDA's Economic Research Service and longitudinal yield data collected by USDA's Statistical Reporting Service. A summary of the Herfindahl indices, crop yields, land values, the FEDS sample (including enterprise sizes) and engineering coefficients of harvesters are also presented.

The analysis section is organized by commodity. There are sections for corn, soybeans, wheat, rice and cotton in that order. Each section follows the same format. First there is a discussion of size economies by selected producing areas followed by an analysis of the source(s) of size economies. Then there is a presentation of comparative advantage, including the relationship between comparative advantage and size economies followed by an analysis of the source(s) of comparative advantage. Each of these commodity sections includes a summary of the size economy indices and "scoring table"; yield; total cost per unit of output and per acre; preharvest, harvest, and ownership costs; a disaggregation of preharvest and ownership costs, custom harvesting and irrigation costs where appropriate; trends in yields and land prices; and rates of fertilization. Most of this information is presented for use in the analysis of size economies and again in the analysis of comparative advantage. Each of the five sections is written "in parallel" across sections to facilitate referencing and cross-commodity analysis.

The concluding section includes a summary of tentative conclusions by commodity from the analysis sections. This section also includes a discussion of "structural elasticity" and a "sensitivity analysis" relative to the return to land for each commodity. Then there is a presentation of hypotheses and tentative conclusions regarding size economies, comparative advantage, and the interrelationships among them. Finally, there is a discussion of the feasibility of generalizing from the enterprise results to the whole farm.

CHAPTER II

THEORY, METHODOLOGY AND DATA

This section provides an overview of the theory, methodology and data associated with economies of size and comparative advantage used in this study. The theory of size economies relates to a firm's long-run average cost curve. The shape of the long-run average cost curve in turn relates to the presence of pecuniary and technological internal economies and diseconomies. Generalization about aggregate movements along the long-run average cost curve provide the basis for theories of economic growth and development. The methods for estimating size economies include production costs for different sizes of representative enterprises, a measure of the extent of utilization of harvesting machines, and the survivor technique with the associated Herfindahl indices. These measures of size economies are used as evidence in building a case regarding the existence of size economies for the various commodities. Measures of intra-industry comparative advantage are derived from information on size economies and provides another dimension to the discussion of the data used in this study. The Firm Enterprise Data System (FEDS), collected by the USDA on enterprise production practices and the Census of Agriculture data collected by the U.S. Department of Commerce are the primary data sources for this study.

2.1 A Theory of Economies of Size and Long-Run Average Cost

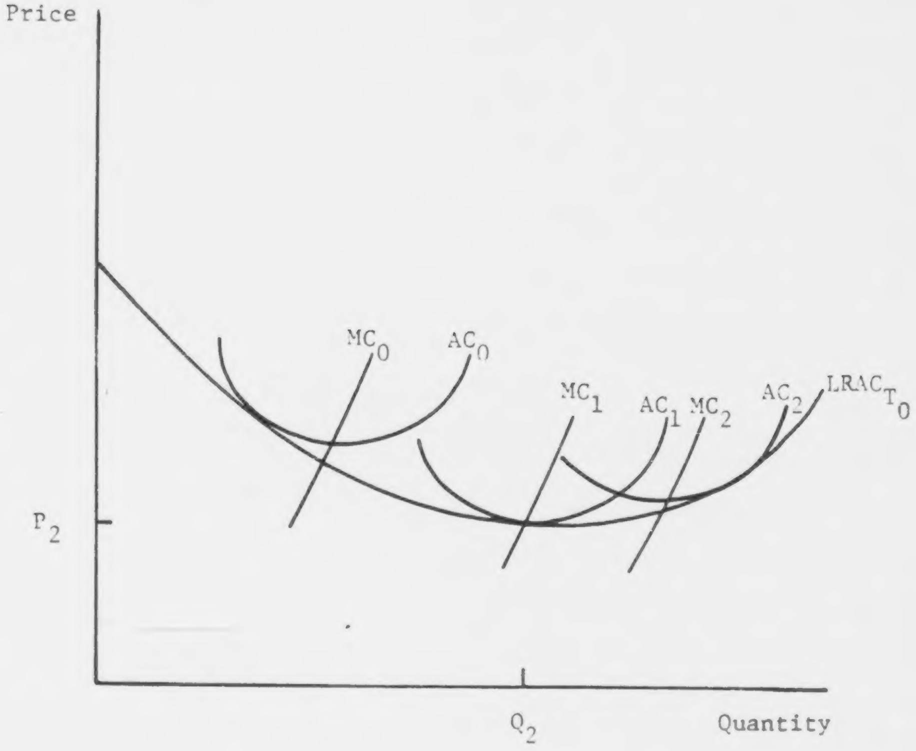
Economies of size refers to the notion that the value or quality of one or more required resources is dependent upon the scale of output for the firm (Viner, 1931, pp. 62-74). "Economies of scale is a special case of economies of size. In the case of economies of scale, all inputs are increased by an equi-proportionate amount ... Since firms are unlikely to increase all their inputs by equal proportions, the economies of scale measures is a relatively restrictive one. Economies of size, on the other hand, measure the change in unit costs associated with a change in some or all of the firm's inputs." (Vlastuin et al., 1982, p. 30).

In terms of economic cost functions, economies of size or increasing returns to size relates to the downward sloping portion of the hypothesized U-shaped long-run average cost curve for the firm. Diseconomies of size or decreasing returns to size, on the other hand, relates to the upward sloping portion of a firm's long-run average cost curve (Walters, 1963, pp. 39-52). The generally accepted theoretical model of the long-run average cost curve is U-shaped for firms in a competitive industry. However, empirical estimates of the shape of the long-run average cost curve based either on time series or cross sectional data fail to confirm the U-shape and suggest rather consistently an L-shape (Walters, 1963, pp. 48-49). These studies of the shape of the long-run average cost curve are not generally accepted as conclusive nor are they accepted as critical tests of the U-shape hypothesis. The reason the upward sloping position of the long-run average cost curve is seldom observed is because no producer would freely choose to produce in this area of increasing cost per unit. Therefore few if any empirical observations of producers doing so are available (Walters, 1963, p. 44, fn 51). Others have suggested however that some producers should be observed on this upward sloping portion of the long-run average cost curve because of management mistakes (Walters, 1963, p. 44; Friedman, 1955, pp. 231-232). The theoretical task then is one of explaining this inconsistency between the hypothesized U-shape and the empirically estimated L-shape models of long-run average cost. By so doing we can describe and predict the general circumstances associated with economies and diseconomies of size.

The long-run average cost curve is often described as an envelope curve approximated by the locus of minimum points of short-run average cost curves for a firm (Viner, 1931, p. 66, fn. 16). See Figure 2. Each short-run average cost curve represents the optimum or full utilization for each plant and machinery size. Thus the full utilization of plant and machinery is a necessary though not sufficient condition for achieving the full potential of economies of size. In general, however, economies of size do not refer to the "spreading of overhead costs" through "fuller utilization of plant" (Viner, 1931, p. 65; Madden, 1963, p. 3).

Further the shape of the long-run average cost curve and therefore the optimum scale of operation for the firm is independent of the level of output for the industry as a whole (Viner, 1931, p. 65). "Internal economies of large scale production ...may be accruing to a particular concern whose output is increasing at the same time that the output for the industry as a whole is undergoing a decline" (Viner, 1931, p. 65). Changes in the level of a firm's average cost per unit of output are associated with external economies and

Figure 2. Long-Run Average Cost Curve as Envelope Curve


Price
MC_0
AC_0
MC_1
AC_1
MC_2
AC_2
$LRAC_{T_0}$
P_2
Q_2
Quantity

diseconomies resulting from a change in output for the industry as a whole. The effect of external economies are such that "...the average costs of the member concerns of that industry will fall even though each concern maintains a constant scale of plant and a constant output" (Viner, 1931, p. 69). The predominance of external economies results in a downward sloping industry long-run supply curve and is unrelated to the downward sloping portion of a firm's long-run average cost curve. Similarly the predominance of external diseconomies results in an upward sloping industry long-run average cost curve (Viner, 1931, pp. 69-74). Let us turn our attention from what a long-run average cost curve is not to what it is fundamentally.

The downward sloping portion of a firm's long-run average cost curve reflects the process of fully exploiting pecuniary and/or technological internal economies. These then are the element of economies of size. Pecuniary economies are defined as the cost savings on required resources used per unit of output resulting from the advantages in buying associated with an increase in the scale of purchases and larger scale of production (Viner, 1931, p. 65). Quantity discounts for one or more of the resources purchased by the firm is a general example of pecuniary internal economies. Quantity premiums for the commodity sold associated with an increase in the scale of production is another example of pecuniary internal economies. The discounts and premiums are often the result of cost savings in these respective markets in which resources or first-handler firms also realize internal economies. Scale related input and output prices are subject to public and private or market decisions.

The major source of economies of size, however, are probably those associated with technological economies. Technological economies are defined as the increases in productivity of the required resources used per unit of output resulting from a firm's improved organization or method of production made possible by a large scale of production (Viner, 1931, p. 65). Specialized production practices, more efficient larger machines, and more specialized labor and management are general examples of technological internal economies. Typically technological internal economies result from substituting more efficient, larger and more specialized capital intensive durables for less efficient, smaller and less specialized durables as well as less specialized labor. As capital intensive durables are substituted for labor, the cost of labor coordination is reduced. The remaining labor and management will become more specialized and thereby more productive (Saving, 1961, p. 588). Empirically it has been shown that economies of size are highly correlated with capital intensity (Saving, 1961, p. 591). The availability of scale related capital intensive technology is subject to public and private research and development policy.

The upward sloping portion of a firm's long-run average cost curve is related to pecuniary and technological internal diseconomies. These are the elements of diseconomies of size. Pecuniary internal diseconomies are defined as the additional cost (or lack of availability) of required resources per unit of output resulting from the disadvantages in buying an increased quantity of resources needed in larger scale production. Quantity premiums for one or more resources purchased by the firm is a general example of pecuniary internal diseconomies. Capital rationing associated with the increased risk and uncertainty of larger scale production represents the major source of pecuniary internal diseconomies (Johnson, 1947, p. 63). "Capital rationing...is represented by the inability of the borrower to obtain all the funds desired at a going rate of interest." (Johnson, 1947, p. 62). Capital rationing affects the scale of production by affecting the resource mix in favor of a low physical capital to labor ratio (Johnson, 1947, p. 64-65). Scale related input prices and quantities including the cost and availability of investment capital are subject to public as well as private or market decisions.

Diseconomies of size are also associated with technological internal diseconomies. Technological internal diseconomies are defined as the decrease in productivity of required resources used per unit of output resulting from the deterioration in a firm's organization or methods of production associated with a larger scale of operation (Viner, 1931, pp. 68-69). Specialized production practices may result in the loss of the beneficial effects associated with less specialized production practices. For example, specialization in agriculture has resulted in monocropping which has replaced crop rotation. Crop rotation is a useful technique for conserving soil fertility, preventing soil erosion and controlling pests. Further increasingly specialized production practices (such as increased use of chemical fertilizers and pesticides) may create negative externalities which may be less cost effective if all costs are internalized to the firm. Assigning responsibility for negative externalities is subject to public as well as private or market decisions.

This description of the forces which effect the shape of long-run average cost curve provides a context within which to predict the general circumstances associated with economies and diseconomies of size. The major forces influencing the decision regarding firm size are technological internal economies associated with the adoption of capital intensive durables and pecuniary internal diseconomies associated with capital rationing and risk aversion in the face of increasing risk and uncertainty as the scale of production increases. It is the thesis of this presentation that these two forces together are largely responsible for explaining average firm size. Further it is a mistake to view size economies and diseconomies in this context as simple inverse functions derived from the same set of incentives.

The option of adopting capital intensive durables is made possible by previous investment in research and development. Thus research and development is the source of the downward sloping portion of the long-run average cost curve ultimately. The adoption of the new technology comes about as a decision on the part of the producer to maximize profit over a period of time (Cochrane, 1958, p. 95). The simple inverse of this process is, for example, technological internal diseconomies associated with the internalizing of negative externalities associated with increasing specialization.

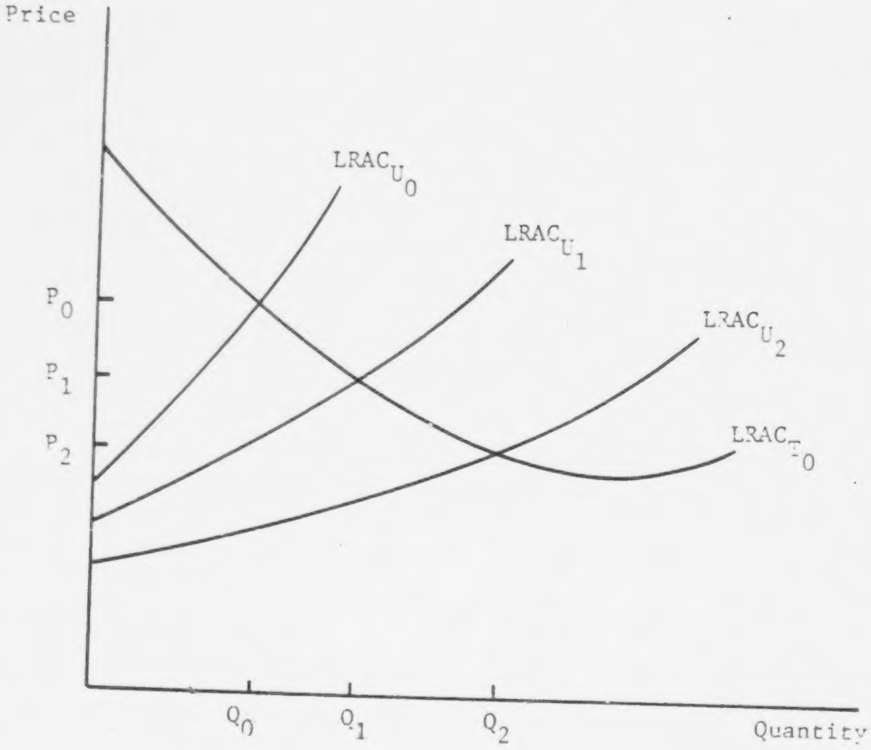
The existence of capital rationing is the result of risk and uncertainty brought about primarily by commodity and resource price variablity (Johnson, 1947, p. 41). Another major source of uncertainty in agriculture is the weather in general and "rainfall, temperature, wind, plant disease and other natural forces" in particular (Johnson, 1947, pp. 40-41). Long-run strategies by producers to deal with risk and uncertainty include diversification, flexibility, liquidity and internal capital rationing (Johnson, 1947, pp. 48-57).

These long-run strategies are adopted by producers not to maximize profits but rather to protect the "capital value of the firm" and as insurance against the firms liquidation in order to survive as a viable concern (Johnson, 1947, pp. 39). A simple inverse of this process does not appear to exist. This implies that pecuniary external diseconomies associated with risk and uncertainty are a positive increasing function of total output.

Graphically we can illustrate the relationship which exists between the process of adopting capital-intensive durables and the strategies for minimizing undue exposure to risk and uncertainty. See Figure 3. $LRAC_{T_o}$ represents the long-run average cost curve for a firm as it adopts more specialized, efficient and larger capital intensive durables in the production process. The shape of $LRAC_{T_o}$ is determined by the technology available at time T_o. Conceivably $LRAC_{T_o}$ can be associated with current as well as future technology so that the adoption of new technology represents a movement along $LRAC_{T_o}$ by the firm. The downward sloping portion of this curve is associated with technological internal economies while the upward sloping portion is associated with technological internal diseconomies. This is the model of long-run average cost which economists generally have in mind when they undertake to estimate size economies empirically.

The $LRAC_{U_i}$ curves represent the pecuniary internal diseconomies associated with internal and external capital rationing resulting from increasing risk and uncertainty. The position of the $LRAC_{U_i}$ curves is determined by the individual producers rational expectation regarding variability in commodity and resource price levels as well as weather patterns in the long run. The greater the uncertainty, or variance in

Figure 3. Composite Long-Run Average Cost Curve



prices and yields, the further to the left is the long-run "capital rationing" curve. "The entrepreneur is faced with the necessity of taking certain precautionary measures to reduce the possibility that the nature of the income stream will force a liquidation of all or part of the capital assests of the firm." (Johnson, 1947, p. 39). "Because of capital rationing the entrepreneur may not be able to extend the scale of the firm to the point desired" (Johnson, 1947, p. 65).

Public programs in agriculture which reduce commodity price uncertainty include loan rates and target prices. Federal crop insurance reduces uncertainty associated with yield. The Farmers Home Administration helps reduce capital rationing in agriculture directly by making loans at subsidized interest rates and through loan guarantees. These policies result in an overall reduction in the level of uncertainty and capital rationing. The result is a shift in the long-run capital rationing curve for $LRAC_{U_o}$ to $LRAC_{U_1}$. Agricultural producers in the early 1950s in the United States were in the process of adjustment from point a to point b in Figure 3. The process of adjustment included an increase in the rate of adopting capital-intensive technology, increased specialization in production by region of the country and the incentive to increase average farm size in the absence of production controls. This process was carefully documented in three classic studies of as many commodities. These studies are Burley Tobacco Control Programs by Glenn L. Johnson (1952); The Impact of Government Programs on the Potato Industry by Roger Gray, Vernon Sorenson and Willard W. Cochrane (1954) and The Effect of the Price Support Program on the Dry Bean Industry in Michigan by

D.E. Hathaway (1955).

The movement from point a to point b represents a movement along the inelastic (or less elastic) portion of a firm's "technological" long-run average cost curve. "Structural elasticity" can be defined as the percentage change in enterprise size divided by the percentage change in long-run average cost. When the absolute value of the structural elasticity is less 1, then the percentage change in enterprise size is less than a given percentage change in long-run average cost. When the absolute value of the structural elasticity is greater than 1, then the percentage change in enterprise size is greater than a given percentage change in long-run average cost. The latter is the situation associated with the movement from point b to point c. Therefore it is very helpful to know the shape of downward sloping portion of the technological long-run average cost curve. As pointed out in a recent U.S.D.A. report "if economies of size are constant over some range of farm sizes, efficient food production may be possible under several alternative structures of the farm sector" (Miller, 1979, p. 108). Therefore, it is a matter of public choice as to the extent society wants to reduce uncertainty in agriculture to achieve lower long-run average costs as opposed to maintaining "family farms" of a particular average size. Over the range of constant returns to size (the horizontal portion of the long-run average cost curve) a structures policy does not conflict with the goal of most efficient production. The objective of this study is to estimate the "elasticity" of the downward sloping portion of the technological long-run average cost curve and associated technological internal economies of size.

This composite long-run average cost curve model provides us with a useful tool to explain the L-shape empirical results from past studies. This model also provides a useful point of departure for understanding the dynamics of agricultural adjustment. The L-shape empirical estimates of the long-run average cost curve are not surprising in light of the composite long-run average cost curve model. We are not likely to observe producers on the upward sloping portion of their technological long-run average average cost curve because internal and external capital rationing have effectively truncated this curve by limiting the investment capital needed to operate in this region of the technological long-run average cost curve. The "capital-rationing" curve and the "technology" curve will probably rarely, if ever, intersect to the right of the minimum point of the "technology" curve. Therefore, internal and external capital rationing would virtually preclude all mistakes associated with excessive scale.

Aggregate movement along the downward sloping portion of the technological long-run average cost curve can be generalized into a theory of technological advance. Joseph Schumpeter provides just such a theory in The Theory of Economic Development (1936). In agriculture Willard W. Cochrane has "adapted those notions to the agricultural economy" in Farm Prices: Myth and Reality (1958). Schumpeter referred to this process as "the gales of creative destruction" while Cochrane refers to it as "the treadmill." The structure of incentives is the key element for enticing producers to move along their technological long-run average cost or planning curve. When the constraints of uncertainty in agriculture are reduced through commodity price, credit and crop insurance programs, then the incentive for early adopters to adopt new technology comes from their ability to capture short-run profits or quasi-rents. Other producers must adopt the new technology to remain competitive with the early adopters. As capital-intensive new technology is adopted, the average cost of production decreases and average firm size increases as firms move along the downward sloping portion of the technological long-run average cost curve. Production for the industry as a whole expands and the commodity price decreases. Consumers benefit by lower food prices, resource owners benefit through additional rent accruing to scarce resources required in production, early adopters receive a short-run quasi-rent and the economy benefits through the release of unspecialized resources from agriculture given the inelastic demand for raw agricultural products. The owners of obsolete resources specialized to the particular agricultural industry, however, lose the the value of these resources given their lack of alternative uses elsewhere in the economy. This is the "destruction of value" Schumpeter was referring to in the phrase "gales of creative destruction."

This "treadmill" process of technological adoption is influenced by public policies other than those relating to commodity price, credit and insurance. Public policy can promote technological innovation and reduce the cost of capital-intensive agriculture. Public programs which promote technological innovation in agriculture include agricultural research and development institutions such as the USDA's research agencies, the state agricultural experiment stations and extension services as well as associated land-grant universities. Public policies which reduce the capital cost of agriculture other than subsidized credit and loan guarantees include investment tax credits, accelerated depreciation, capital gains and cash accounting provisions of the federal tax code. Public policies and public agencies which develop and/or promote capital-intensive agricultural innovation are directly responsible for making technological internal size economies possible. The social desirability of this relationship is currently being tested in the state courts in California (California Agrarian Project v. The University of California).

There is nothing in either the Schumpeter or Cochrane theories which would suggest that the returns to investments after adopting a new technology would be less than before adoption. If anything, the Schumpeter/Cochrane notion should result in higher than average returns to investment at least in the short-run because of quasi-rents. The fact is that in the agricultural sector, the income generated reflects in a rate of return to resources which is almost always less than the return to resources in the nonfarm economy. (U.S.D.A., 1979, p. 4). Tweeten in Foundations of Farm Policy (1979) has attributed chronic low returns in agriculture to the fact that large efficient producers have bid up the price of land so much that smaller less efficient producers receive a low rate of return on investment relative to current market values (pp. 184-189). This line of reasoning raises the question as to why the less efficient producers have not increased efficiency by increasing the scale of their operation or exited from the industry by liquidating their assets at a high rate of return by selling them to the more efficient producers. We know that resources are released from agriculture as productivity increases because demand for farm products is inelastic. We also know that the owners of obsolete specialized resources will suffer a capital loss as more efficient resources are adopted in production. Non-specialized resources are released and available to be reabsorbed into the economy at the original acquisition price. However G. L. Johnson in The Overproduction Trap in U.S. Agriculture has indicated that the capital loss associated with devalued capital assets is much more prevasive than generally assumed (1972, p. 26). The Johnson thesis is that nearly all resources including human capital used in agriculture are specialized to a degree. The resources are purchased initially at a given acquisition price. When these same resources are resold outside of the enterprise, within or without the agricultural sector, then these resources bring a substantially lower salvage price even after adjustments are made for depreciation and maintenance (Johnson, 1972, p. 26). This difference between acquisition and salvage price represents a barrier to exit for the less efficient producers. Smaller scale operations continue to exist because the rate of return on their resources is greater in production than it is as salvage. Moreover, at least some of the human resources involved have limited employment opportunities outside of agriculture.

Johnson describes the effect of low salvage prices on technological adoption and implicitly technological internal economies of size as follows:

> ...the farmer is constrained to continue to use the older capital items until such time as the discounted value of the expected MVP's falls to or below salvage values despite failure to recover the original investment...the result is that the present is always characterized by a stock of obsolete capital that is fixed but is not capable of covering its original acquisition costs. (1972, p. 37).

The Johnson overproduction trap results in a large number of firms producing on a smaller scale of operation with less productive capital stock, receiving a lower average rate of return than would be predicted by the Schumpeter/Cochrane treadmill theory. In effect, the Johnson thesis seems to imply that the retention of inefficient smaller firms prevent the efficient larger firms from earning an equilibrium rate of return for their resources in agriculture. The Tweeten thesis implies the reverse - that the efficient larger firms prevent the inefficient smaller firms from earning an equilibrium rate of return.

Ironically the same public policies which reduce risk, uncertainty, and capital rationing, thereby allowing the adoption of the technological innovation, are the same policies which allow the less efficient producers to remain in agriculture. The commodity programs assure that commodity prices multiplied by the marginal physical product of an obsolete durable will remain greater than the durable's salvage value. Similarly credit programs help to maintain some less efficient producers by subsidizing production credit used to purchase the variable resources which complement the devalued durable resources. The dual role of commodity price programs suggest the seeming contradictory hypothesis posed by Cochrane "... logic suggests that the higher the level at which product prices are stabilized, the more rapid and widespread will be technological advance in farming...high and stable prices may help the weak and inefficient to stay in business." (1983, p. 7). Johnson's theory suggest the following alternative hypothesis. High commodity prices would allow inefficient producers to liquidate their assets above or equal to acquisition price. Low commodity prices would force inefficient producers to liquidate their assets at salvage value. A moderate commodity price may force the weak and inefficient to remain in business since the return to the assets in production is greater than salvage price though less than acquisition price.

2.2 Empirical Considerations

There are several empirical issues that we must address before we begin to estimate economies of size for the various agricultural commodities. We need to begin with a clear statement of purpose for estimating economies of size. A well defined purpose will help to assure well defined results. We need to address the issues of aggregation, specialization, comparative advantage and rent relative to estimating size economies. The resolution of these issues should also help to direct this study toward results which are clear, understandable and meet the objectives squarely.

We want information on economies of size in corn, soybeans, wheat, rice and cotton in order to provide empirical evidence as a key indicator of resource efficiency, resource concentration and agricultural structure. The information on economies of size is required to develop a "structural elasticity" measure which is the critical measure underlying the poltical debate regarding the "family farm." If technological internal size economies exist then a trade-off between efficiency and structure is at issue. If they do not exist then the case for a structure of agriculture policy need not include a debate regarding efficiency. Instead resource concentration and structure become the issue. If we combine information regarding economies of size with information on comparative advantage then we can better understand the strategies regarding the exploitation of size economies used by producers of the same commodity in various areas of the country. An understanding of producers' strategies in exploiting size economies will provide policy makers with an insight into the differential effect of a structure policy in areas with different comparative advantage. Finally, empirical estimates of size economies may provide some insight as to which theory of agricultural development most nearly corresponds to current reality.

The level of aggregation in estimating economies of size relates to specialization and initial resource endowments. If there were no specialized resources and no differences in the quality of these resources in the production process then all enterprises in all areas of the country would have a similar long-run average cost curve. Differences in sizes between areas would be a matter of mistakes and large and small enterprises would converge toward a single optimal size (Friedman, 1955, pp. 231-232). However, there is specialization in agriculture resulting from heterogeneous initial resource endowments - land, labor, capital, energy, materials and annual weather conditions. The differences in inital resource endowment affects the combination of resources in the production of the same commodity. This difference in the combination of resources results, in turn, in a variation in the least-cost size and productivity of firms across regions of the country. The result then is that firms producing a given commodity would converge on a optimal range rather than on a single size. This difference in initial resource endowments can be accounted for by defining homogeneous production areas to the extent possible. Size economies can then be estimated for a single homogeneous production area. And differences in productivity and relative prices among production areas can be measured in terms of comparative advantage.

Comparative advantage refers to the notion that despite different geographic locations and initial resource endowments "...firms must operate at points on their respective production possibilities frontier at which their rates of product transformation are equal" (Nicholson, 1972, pp. 415-416). Comparative advantage as it is used in this study equals absolute advantage in that we assume linear production possibilities frontiers and constant commodity price ratios (Heady, 1952, pp. 657-661). However, areas with similar comparative advantage need not have firms of similar least-cost size. Thus, comparative advantage provides a context within which to understand the importance of size economies. Economies of size, in turn, help in understanding one possible source of comparative advantage. Economies of size can be viewed as intra-enterprise productivity comparisons by size within a region. Comparative advantage can be viewed, in part, as an interregional productivity comparison. In sum, we will be able to analyze intra-enterprise productivity and size decisions in light of interregional productivity.

Both the concepts of economies of size and comparative advantage derive their meaning from a definition of average cost. There is a truism in economic theory that in the long-run equilibrium price equals average cost. This truism holds for all size firms regardless of comparative advantage. The logic of this proposition resulted in Friedman's criticism of cross-sectional economies of size studies

> ...cross-section accounting data on costs tell nothing about "economies of scale" in any meaningful sense. If firms differ in size because they use different specialized resources, their average costs will tend to be equal, provided they are properly computed so as to include rents. Whether actually computed costs are or are not equal can only tell us something about the state

> of the capital market or of the accounting profession. (1955, pp. 234-235).

Friedman retreats somewhat from this blanket condemnation of cross-sectional economies of size studies.

> The particular question may well suggest relevant criteria for distinguishing one kind of cost from another, and in this way enable cross-section accounting data to provide useful information. (1955, p. 238).

The rational for using cross-sectional data to measure differences in economies of size and comparative advantage turns on the difference between long-run and short-run equilibrium conditions. Viner describe this distinction between the long and short-run effect on production costs as follows:

> under long-run static competitive equilibrium marginal costs and average costs must be uniform for all producers. If there are particular units of the factors which retain permanent advantages in value productivity over other units of similar factors, these units, if hired, will have to be paid for in the long-run at differential rates proportional to their value productivity... and should be capitalized accordingly. In the short-run the situation is different. There may be transitory fluctuations in the efficiency of particular entrepreneurs or of particular units of the factors, and it would neither be practicable nor sensible to recapitalize every unit of invested resource with every fluctuation in its rate of yield...there may be substantial variation as between the average costs...of different producers. (1931, p. 74-75).

Viner elaborates further on this point:

> under short-run equilibrium the average costs, including the fixed costs, of any particular producer need bear no necessary relationship to price, except that the average direct costs must not exceed price.....statistical costs moreover, are not the equilibrium cost of the theoretical short run, but are the costs as they exist at an actual moment of time (1931, p. 75).

It is therefore assumed that the difference between average cost by enterprise size and area of the country is a measure of the "transitory" difference in rent which would accrue to specialized resources in the long-run. This measure of relative differences in rent is the implicit measure of size economies and comparative advantage. Also we will be estimating the minimum points of array of short-run average cost curves to describe the range of least-cost enterprise of sizes for various areas of the country producing the same commodity.

2.3 Enterprise Budgets

Enterprise budgets represent actual costs of a farm firm for one "subproduction function". Typically, agricultural firms produce more than one commodity given the complementary nature of some resources which can be more fully utilized and thereby receive a higher average return by producing more than one crop. Resources for each enterprise are organized in such a way that the marginal value products of the resources are equal in the production of each commodity. Thus, for producers to select the profit maximizing enterprise combinations they must correctly estimate the future commodity price. In addition, producers must know the subproduction functions. Knowledge of a subproduction function includes knowing the scale of production which exploits technological internal economies of size. Therefore, using enterprise budgets to estimate economies of size and comparative advantage is a necessary condition for firm decision making. It is in light of this relationship between an enterprise and a farm firm that we focus our analysis on the enterprise. We will return to this point again however in the conclusion section of this study.

The process of determining economies of size for the selected field crops first requires the definition of homogeneous production areas, these are based on U.S.D.A. Firm Enterprise Data System (FEDS) designation of contiguous counties within each state with similar soil type and/or rainfall. See Table 4. It is assumed that enterprises

Table 4. Homogeneous Production Areas for the Various Commodities

Production Areas	Abbreviations and FEDS Designation
Corn	
East Central Illinois	IL 300
Central Indiana	IN 101
North Central Iowa	IO 201
South Central Nebraska	NE 400
Soybeans	
East Central Illinois	IL 300
North Central Iowa	IO 201
Mississippi Delta	MS 100
Western Ohio	OH 101
Wheat	
Western Kansas	KS 100
North East Montana	MT 200
Central North Dakota	ND 200
Eastern Washington	WA 400
Rice	
North Central California	CA 400
Texas Upper Gulf Coast	TX 100
Mississippi and Arkansas Delta	DLT 100 & 300
North East Arkansas	AK 200
Cotton	
Northern Alabama	AL 600
South Central California	CA 500
Mississippi Delta	MS 100
Texas High Plains	TX 200

within these areas using a combination of resources would result in convergence toward an optimal economies of size. The production areas were selected on the basis of importance of these areas in growing the various commodities and to provide some variability in cost structure due to differences in technology and yields. Table 5 shows the percentage of U.S. total production each of the selected areas represents based on a five-year average. The total production in the selected production areas as a percentage of U.S. production ranges from about 10% for wheat to about 70% for rice. Selected corn and soybeans areas represent approximately 20% of U.S. production each while selected cotton areas represent about 50% of the total U.S. production.

Once homogeneous production areas are selected the next task is to collect production data for selected commodities in the various production areas. The U.S. Department of Agriculture, Economic Research Service, under the direction of Krenz has developed a pool of production cost data for field crops by FEDS production areas for the entire nation. These production data are based on periodic surveys of a sample of producers within each production area. These producers are interviewed in person by enumerators regarding their production practices in growing, harvesting, transporting and storing a particular commodity. This survey process was begun in 1974 and conducted approximately every four years thereafter. Each survey is based on a new sample of producers. (Coincidentally, the timing of the FEDS surveys is the same as that for the U.S. Department of Commerce's Census of Agriculture). The latest FEDS survey was begun in the fall of 1982 and completed in the spring of 1984. Rice producers have only been surveyed once and that survey was conducted for

Table 5. The Selected Areas Production as a Percent of Total U. S. Production for Respective Commodities Based on a Five-Year Average from 1979 to 1983

Corn		Soybeans		Wheat		Rice		Cotton	
State & Area	%	State & Area	%	State & Area	%	State & Area	%	State & Area	%
IL 300	7.6	IL 300	7.8	KS 100	3.4	CA 400*	22.0	AL 600	1.7
IN 101	4.5	IO 201	5.3	MT 200	1.0	TX 1001*	13.8	CA 500*	22.6
IO 201	5.4	MS 100	1.9	ND 200	1.7	DLT 100-300*	12.6	MS 100	8.0
NE 400	2.7	OH 101	3.4	WA 400	3.0	AK 200*	19.5	TX 200*	9.9
								TX 200	7.4
Total	20.2		18.4		9.1		67.9	Total	49.6

* Irrigated.

Source of Data: U.S. Dept. of Agriculture, Statistical Reporting Service, "County Production Data for the U.S. by Commodity for 1972 to 1983" available on tape.

U.S. Dept. of Agriculture, "Corn; Soybeans; Wheat; Rice; Cotton: Background for the 1985 Farm Legislation" Economic Research Service, Agricultural Information Bulletings No. 471, 472, 467, 470 and 476 respectively.

1979. The 1982 survey was divided so that producers in the states in the South, Southwest and California (associated generally with cotton production) were surveyed in 1983 regarding the 1982 crop year. The remaining areas of the country were surveyed in the spring of 1984 regarding the 1983 crop year. The total sample of producers drawn from the most recent survey year for the selected commodities in the various producing areas is presented in Table 6. The sample of producers within the production areas ranges from 13 to a 102 with a mean of 47 and a standard deviation of 21 observations.

In order to construct a long-run average cost curve from enterprise budgets "the (enterprise) records are first separated in to size classes. Within each size class a composite (enterprise) is developed using averages of the various recorded items....." (Madden, 1967, p. 27). For the purposes of this study we are particularly interested in whether very large enterprises enjoy size economies relative to large and medium size enterprises. Therefore, we arrayed the FEDS sample of producers in each area in increasing order of enterprise size measured in terms of planted acres. We then defined the 90th decile of each array as "very large" enterprises, the 70th through 80th deciles as "large" enterprises and the 40th through 60th deciles as "medium" enterprises. The small enterprises (10th through 30th deciles) were not included in this study because these producers represent a very small proportion of total output and because substantial size economies can be adequately measured for the medium enterprise size relative to these smaller units. Table 7 shows the percentage of total production produced by the 40th through 90th deciles of enterprises in 1982. The top 60% of the enterprises in the

Table 6. The FEDS Survey Sample Size by the Selected Production Areas for the Respective Commodities for the Most Recent Survey Year

Corn1/			Soybeans1/			Wheat1/			Rice2/			Cotton3/		
State	Area	N4/	State	Area	N4/	State	Area	N4/	State	Area	N4/	State	Area	N4/
IL	300	36	IL	300	48	KS	100	71	CA	400*	67	AL	600	31
IN	101	36	IO	201	36	MT	200	46	TX	1001*	57	CA	500*	52
IO	201	25	MS	100	13	ND	200	61	DLT	100-300*	78	MS	100	40
NE	400*	27	OH	101	29	WA	400	33	AK	200*	102	TX	200*	58
												TX	200	40

1/ 1983 Data.

2/ 1979 Data.

3/ 1982 Data.

4/ N equals the number of observations in the original sample for the survey area.

* Irrigated

Source of Data: U.S. Dept. of Agriculture, Firm Enterprise Data System, National Survey of Producers of Agricultural Commodities, raw data unpublished.

Table 7. The Percentage of Total Output Produced by the 40th Through 90th Deciles of Farms by State for the Selected Commodities

Corn			Soybeans			Wheat			Rice			Cotton		
State	Area	%	State	Area	%	State	Area	%	State	Area	%	State	Area	%
IL	300	95	IL	300	92	KS	100	93	CA*	400	93	AL	600	96
IN	101	95	IO	201	88	MT	200	92	TX*	1001	87	CA*	500	97
IO	201	93	MS	100	96	ND	200	88	DLT*	100-300	87	MS	100	96
NE*	400	89	OH	101	93	WA	400	92	AK*	200	90	TX*	200	99
												TX	200	95

Source of Data: U.S. Dept. of Commerce, 1982 Census of Agriculture, State Data Table 41, "Specified Crops by Acres Harvested: 1982 and 1978" for respective states.

* Irrigated

selected areas produce on average about 93% of the total output of the commodities considered with a standard deviation of only about 3 percentage points. This data implies that the smallest 40% of the producers account for only about 5 to 10 percent of the total output in these commodities in the selected production areas.

The results of the subdivided FEDS survey sample is presented in Table 8. In production areas where the total sample survey is less than 25 observations, a minimum of three producers are included in each subsample to avoid the possibility of disclosure. Included with the information on the size of each subsample is the average enterprise size in terms of planted acres associated with it. Table 9 provides information on the range in enterprise sizes within the subsample of the production areas for the selected commodities. The FEDS survey sample for a production area is drawn to provide statistically reliable information on the cost of producing a commodity on a representative acre of land in that area taken as a whole. Consequently, when the sample is subdivided, as it must be in order to differentiate by size of enterprise, the sample size is reduced. This reduction in sample size makes the statistical reliability of the information by size category questionable. As a result "representative" enterprises based on this data may not be representative of the base farm population, but more like a case study. However, having stated this caveat, it is also important to note that no other systematically collected U.S. field crop production data exists. These data are particularly useful in light of the uniformity in survey information collected and sampling technique used for each crop within the same crop year. Further, these data do accurately reflect the cost of production for

Table 8. The FEDS Survey Sample Size by Production Area and Associated Enterprise Size

	Corn1/		Soybeans1/		Wheat1/		Rice2/		Cotton 3/	
	Sample Size	Planted Acres	Sample Size	Planted Acres	Sample Size	Planted Acres	Sample Size	Planted Acres	Sample Size	Planted Acres
	IL 300		IL 300		KS 100		CA 400*		AL 600	
Total	36	326	48	295	71	1032	67	1071	31	649
VL	4	1113	5	684	7	3909	7	3575	3	1842
L	7	355	10	418	14	1429	13	1502	6	917
M	11	246	13	270	21	774	20	870	9	568
	IN 101		IO 201		MT 200		TX 1001*		CA 500*	
Total	36	323	36	246	46	488	57	802	52	818
VL	4	903	4	707	5	1577	7	2068	5	2833
L	7	515	7	341	9	619	10	1049	10	1432
M	11	271	11	210	14	421	19	691	16	614
	IO 201		MS 100		ND 200		DLT 100 & 300*		MS 100	
Total	25	202	13	783	61	409	78	694	40	899
VL	3	576	3	1262	6	1283	12	1904	4	2868
L	5	249	3	894	12	630	17	853	8	1202
M	8	170	4	795	18	338	19	509	12	754
	NE 400*		OH 101		WA 400		AK 200*		TX 200*	
Total	27	442	29	299	33	836	102	485	40	578
VL	3	1715	3	897	3	2388	9	1619	6	1707
L	5	671	6	493	7	1104	23	720	12	929
M	8	266	9	244	10	753	33	377	17	436
									TX 200	
Total									40	1393
VL									4	5920
L									8	1825
M									12	972

1/ 1983 data 2/ 1979 data 3/ 1982 data *Irrigated

Source of Data: U.S. Dept. of Agriculture, Firm Enterprise Data System, National Survey of Producers of Agricultural Commodities, raw data unpublished.

Table 9. Ranges in Planted Acres by Enterprise Size in the Production Areas for Respective Commodities for the Most Recent FEDS Surveys

	Corn1/		Soybeans1/		Wheat1/		Rice2/		Cotton 3/	
	Planted Acres		Planted Acres		Planted Acres		Planted Acres		Planted Acres	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	IL 300		IL 300		KS 100		CA 400*		AL 600	
VL	2,746	431	899	540	10,500	2,100	5,450	2,190	2,584	1,135
L	430	300	510	350	2,000	1,000	2,162	1,120	1,011	800
M	295	210	345	215	992	560	1,120	600	700	498
	IN 101		IO 210		MT 200		TX 100*		CA 500*	
VL	995	774	1,028	500	3,500	760	2,900	1,700	4,291	2,400
L	641	426	460	280	740	515	1,300	851	1,932	1,040
M	420	181	272	165	515	313	850	507	930	405
	IO 201		MS 100		ND 200		DLT 100-300*		MS 100	
VL	800	433	1,702	985	1,800	801	3,200	1,900	4,260	1,957
L	290	219	947	851	800	440	1,641	775	1,920	876
M	211	115	850	759	440	228	726	300	870	616
	NE 400*		OH 101		WA 400		AK 200*		TX 200*	
VL	2,385	1,200	950	856	3,072	1,841	3,140	1,030	2,500	1,300
L	970	387	620	400	1,340	960	1,030	501	1,290	674
M	380	216	337	130	950	651	500	300	600	300
									TX 200	
VL									14,000	2,764
L									2,372	1,292
M									1,280	651

1/ 1983 Data.   2/ 1979 Data.   3/ 1982 Data.   * Irrigated

Source of Data: U.S. Dept. of Agriculutre, Firm Enterprise Data System, National Survey of Producers of Agricultural Commodities, raw data unpublished.

the particular enterprises sampled and are at least suggestive of the differences one might expect to find among size categories.

The next step in deriving a long-run average cost curve for an area using enterprise budgets is to calculate the short-run average cost per unit of output of the representative enterprise in each size class. "These results are then assumed to be 'typical' of farms in the respective size classes. Comparison of these typical costs yields a size-efficiency relationship" (Madden, 1967, p. 27). The FEDS enterprise production data included information for the following categories:

(1) acres operated and crop land use
(2) general
(3) land tenure
(4) cash rental arrangements
(5) share rental arrangements
(6) fertilizer and lime
(7) herbicides, insecticides and other materials used
(8) trucks and tractors
(9) field operations
(10) planting and harvesting equipment utilization
(11) custom work
(12) labor
(13) irrigation
(14) drying, storage and marketing
(15) drying and storage equipment
(16) acreage reduction and PIK program

The information from the surveys is then summarized for each enterprise size.[1] After the aggregation programs have been "run," size and area representative enterprise budgets are prepared based on a set of assumptions listed below. The estimates of average cost per unit of output are "generated" using a computerized "budget generator".[2]

Enterprise budgets are constructed initially by enterprise size to determine size economies. The enterprise budgets within a production area also provided the basis upon which to construct a representative enterprise budget for the area as a measure of comparative advantage. There are some differences in how size-dependent budgets and area-dependent budgets were constructed. In size-dependent enterprise budgets used to estimate size economies, the price of land was assumed uniform across enterprise size within a production area. For this reason, land as an ownership cost is not included in the calculations of size-dependent enterprise budgets. In area-dependent enterprise budgets used to estimate comparative advantage, the price of land is a very important cost consideration since land is the single most costly resource and land prices vary significantly between the selected production areas. See Table 10. Since we are estimating only technological internal economies, risk is assumed constant across size-dependent enterprise budgets.[1] Holding risk constant across enterprise size within a production area implies in part that all enterprises are equally subject to the variability in yield associated with the weather (See Table 11) and that differences in yield are size related differences in production practices. In the representative enterprise budgets for an area, risk associated with inter-year variability in yield is dealt with by using the five-year average yield for that area. See Table 12.

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[1] The survey data is summarized using computerized aggregation programs written by the USDA/ERS staff stationed at Oklahoma State University and under the direction of Ron Krenz and Gail Garst.

[2] The USDA/ERS version of the budget generator used in this study is a modification of the Oklahoma State University budget generator program written initially by Rodney Walker and Darrel Kletke. The Walker-Kletke program in turn is based on the theoretical work regarding the pricing of a flow of services from a manufactured durable resource by Wendall Bowers (1981). All aggregation and budget results were produced at the University of Minnesota specifically for use in this study.

In both the representative enterprise budgets for size and area, it is assumed that management is the residual claimant to the returns to the production process after other resources are paid. Management "rent" is not included as an explicit cost in either the representative size or area enterprise budgets. If management costs (computed on a residual basis) were included, then the average costs by size and area necessarily equal commodity price because, in an accounting sense total costs must equal total revenues. The returns to management represent the difference between expected and actual costs and represents profit defined as "an unanticipated residual arising from uncertainty." (Friedman, 1955, p. 236). By excluding returns to management, it is possible to study the underlying "short-run" cost variation associated with the remaining resources by enterprise size and production area. Finally, a general farm overhead charge is included as a "variable" cost in calculating both size and area representative enterprise budgets. This variable cost designation is a

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[1] Risk and uncertainty represent the elements of pecuniary internal diseconomies. We assume that uncertainty regarding resource and commodity price preclude observations of enterprise on the upward sloping portion of the technological long-run average cost curve.

Table 10. 1982 Price Per Acre for Land in the Selected Production Areas

Corn			Soybeans			Wheat			Rice[1/]			Cotton		
State	Area	$/Acre	State	Area	$/Acre	State	Area	$/Acre	State	Area	$/Acre	State	Area	$/Acre
Il	300	2168	IL	300	2168	KS	100	546	CA	400*	1492	AL	600	1043
IN	101	1786	IO	201	2092	MT	200	232	TX	1001*	830	CA	500*	2348
IO	201	2092	MS	100	1097	ND	200	448	DLT	100-300*	825	MS	100	1097
NE	400*	915	OH	101	1789	WA	400	818	AK	200*	801	TX	200*	513
												TX	200	513

1/ Land values for 1978.

*Irrigated

Source of Data: U.S. Dept. of Commerce, 1982 and 1978 Census of Agriculture, County Data Table 1 "Farms, Land in Farms and Land Use; Value of Land and Buildings, Average per Acre" for respective state and counties.

Table 11. 1982 Yield Per Harvested Acre in the Selected Production Areas for the Respective Commodities by Enterprise Size

	Corn		Soybeans		Wheat		Rice1/		Cotton	
Enterprise Size	State, Area & Acres	Yield Bushels	State, Area & Acres	Yield Bushels	State, Area & Acres	Yield Bushels	State, Area & Acres	Yield Cwt	State, Area & Acres	Yield Bales
	IL 300		IL 300		KS 100		CA 400*		AL 600	
VL	500+	130.3	999-500	30.2	1000+	33.1	2000+	51.3	1000+	1.52
L	499-250	128.6	499-250	38.2	1000+	33.1	2000-1000	52.6	999-500	1.47
M	249-100	123.1	249-100	37.4	999-500	33.2	999-500	52.1	999-500	1.47
	IN 101		IO 201		MT 200		TX 1001*		CA 500*	
VL	1000+	125.6	999-500	36.8	1000+	31.1	2000+	47.4	1000+	2.28
L	999-500	125.3	499-200	36.6	999-500	29.9	2000-1000	46.3	1000+	2.28
M	499-250	122.4	249-100	36.3	499-250	29.2	999-500	46.4	999-500	2.11
	IO 201		MS 100		ND 200		DLT 100-300*		MS 100	
VL	999-500	119.0	1000+	25.0	1000+	31.7	1000+	39.8	1000+	1.79
L	499-250	117.4	999-500	23.6	999-500	30.8	999-500	42.6	1000+	1.79
M	249-100	113.0	999-500	23.6	499-250	29.7	499-250	43.6	999-000	1.74
	NE 400*		OH 101		WA 400		AK 200*		TX 200*	
VL	1000+	118.6	999-500	35.6	1000+	39.9	1000+	43.1	1000+	.67
L	999-500	112.6	499-250	34.8	1000+	39.9	999-500	44.7	999-500	.69
M	499-250	106.2	249-100	34.4	999-500	47.8	499-250	44.5	499-250	.68
									TX 200	
VL									1000+	.44
L									1000+	.45
M									999-1000	.45

1/ 1978 yields. * Irrigated.

Source of Data: U.S. Dept. of Commerce, 1982 Census of Agriculture, State Data Table 41, "Specified Crops by Acres Harvested: 1982 and 1978" for respective states.

Table 12. The 1979-1983 Average Yield Per Planted Acre in the Selected Production Areas for the Respective Commodities for all Enterprise Sizes

Corn		Soybeans		Wheat		Rice1/		Cotton	
State & Area	Bu.	State & Area	Bu.	State & Area	Bu.	State & Area	Cwt.	State & Area	Bales2/
IL 300	118.4	IL 300	38.6	KS 100	27.8	CA 400*	62.3	AL 600	1.13
IN 101	108.3	IO 201	38.1	MT 200	19.7	TX 1001*	45.9	CA 500*	2.10
IO 201	125.6	MS 100	22.0	ND 200	22.6	DLT 100-300*	40.6	MS 100	1.37
NE 400*	122.5	OH 101	33.8	WA 400	46.6	AK 200*	43.2	TX 200*	.67
								TX 200	.45

1/ 1977-81 Data.

2/ bale = 480 lbs. lint.

Source of Data: U.S. Dept. of Agriculture, Statistical Reporting Service, "County Production data for the U.S. by Commodity, 1972-1983" available on tape.

peculiarity of the version the budget generating program used. The general farm overhead charge is estimated on a per-acre basis and therefore assumed proportional across enterprise size and varies by production area.

Two additional problems remain. The first is that some enterprises in the survey are "operating at less than full capacity" (Madden, 1963, p. 28). The budget generator program is written with the assumption that the specified machinery complement is used to capacity either within the enterprise or within the firm. Since we are approximating the long-run average cost curve by using a series of short-run average cost estimates, it is important to measure the extent to which the costs of manufactured durables are spread over the units of output. In order to take into account the extent of utilization of machinery, we have included as a separate measure of efficiency the extent of harvesting machinery utilization. This measure of efficiency is discussed in more detail in section 2.4.

A second and related problem is that "the composite [enterprises] do not accurately reflect the potential efficiency attainable by [enterprises] of various types. Many existing [enterprises] are using outdated machines, buildings and practices which are grossly inefficient by modern standards" (Madden, 1963, p. 28). The average cost estimates of the budget generator based on actual enterprise production data may not be "good indicators of efficiency that a planning firm could expect to achieve with various size operation" (Madden, 1963, p. 28). This criticism of economies of size estimates for our actual production data relates to the over-production trap associated with barriers to exit. At any point in time, there is a wide array of producers some of whom are producing a commodity efficiently and others who are not. The mean-variance of the distribution of producers' efficiency by size is unknown. There is however a very direct way to determine the desirable and presumably most efficient enterprise size as perceived by the producers themselves. "If we ask what size firm has minimum costs, and define 'minimum costs' in a sense in which it is in a firm's own interest to achieve it, surely the obvious answer is: firms of existing size" (Friedman, 1955, p. 237). Stigler formalized this notion in terms of the "survivor technique" (1958, pp. 54-71). We will use the survivor technique as an additional approach to determine the existence of economies of size. The survivor technique is particularly useful in providing information as to which enterprise sizes are attracting the more efficient producers. The survivor technique and associated Herfindahl measures are discussed in detail in section 2.5.

2.4 Harvesting Machinery Utilization

In order to assure that an enterprise is operating at the minimum cost point on its short-run average cost curve, it is necessary that the resources employed by the firm are fully exploited either within the enterprise or within the firm. Johnson has proposed a resource classification scheme which is useful in analyzing this problem.

> There are three categories of resources which must be considered: (1) the variable resources that can be allocated between the products, (2) the resources that are fixed to the firm but can be allocated in the production of the products, and (3) the resources that are fixed to the firm and cannot be allocated between enterprises (1962, p. 93).

Variable resources are not of concern because the quantity of these resources is determined during each production cycle. Further, if too few of these resources are purchased then additional units can be purchased subsequently for the same price. Presumably if too many of units of these resources are purchased, then these could be resold to others or the original seller at the acquisition price.

Resources which can be allocated between products poses a problem. We have addressed this problem earlier by assuming that these resources are allocated between enterprises so that the marginal value product of the resource is equal across enterprises. We are, in effect, assuming that as the acreage in one enterprise expands, then the size of complementary enterprises within the firm expand or contract as necessary such that the machinery complement is as fully utilized as possible.

The resource which is specialized to the enterprise is the case of primary concern in this section. Durable resources which are fixed to the agricultural enterprise include certain types of planters and harvesters as well as specially designed buildings, sheds and silos. Within the category of capital ownership costs in field crop production, typically the largest cost item is harvesting machinery. We are interested, then, in determining the extent to which excess capacity or under-utilization of this durable resource exists. Madden refers to this process of compensating for the "limitation of cost data obtained from actual firms" as the standardization or adjusted data" technique (1967, p. 28).

We begin the standardization process by assuming that each size-dependent enterprise has approximately the same harvesting machine at least when measured in terms of width or rows. We then use the economic and engineering coefficients for the standardized harvester from the budget generator to determine the implied number of acres a harvester could reasonably be expected to harvest per year when used to full capacity. This process makes explicit some relatively arbitrary assumptions used within the budget generator regarding the rate of extraction of services from the durable, the useful life of the durable and the rate of repairs and maintenance which would effectively extend the useful life of the durable. Within the machinery complement section of the budget generator, each machine is assigned a number of "total service hours" and a "useful life". The total service hours is the measure of the stock of service hours available from the machine. The useful life is an implicit decision as to the rate of extraction of the flow of services from the durable's total stock. Once these two decisions are made, the results can be combined with the engineering coefficients regarding width, field speed and technical efficiency and the relevant constants to derive an equation for the average number of acres harvested per year. The equation used to determine the full utilization of the harvesting machine consistent with the assumptions regarding useful life and total service hours is presented below.

(1) Full utilization of harvesting machine (acres/year) =

[total service hours (hrs)/useful life (yrs)]

* width (ft.) * speed (miles/hr.) * efficiency (%)

* (ft./mile) * (acres/ft^2).

For example, a six-row self-propelled corn harvester is the typical machine used in each of the selected corn producing areas by each enterprise size. The economic and engineering assumptions and constants are as follows:

total service hours:	2000 hrs.
maximum useful life:	20 yrs.
width:	18 ft.
speed:	3 mph
efficiency:	70%
ft/mile:	5280 ft/mile
acres/ft^2:	.000022957 acres/ft^2.

Therefore, the assumed full utilization acreage of a six-row self-propelled corn harvester per year is determined as follows:

(2) Corn harvester full utilization (acres/yr) = [2000 hrs/20 yrs]
$* \ 18 \text{ ft} * 3 \text{ miles/hr} * 70\% * 5280 \text{ ft/mile} * .000022957 \text{ acres/ft}^2$
= 458 acres/yr.

The corn harvester's assumed 2,000 total service hours and 20 years of useful life together imply 100 hours of harvester service annually. However, a producer may use 200 hours of harvester service annually, which would imply a 10 year useful life for the harvester holding the level of maintenance constant. Over a 20 year time span, a producer of 916 acres of corn is assumed to be indifferent between owning two harvesters purchased concurrently and each depreciated over 20 years and two harvesters purchased consecutively and each depreciated over 10 years. In this sense, the 20 year useful life represents a reasonable maximum and the associated 100 hours of annual use represents a reasonable minimum.

A complete list of assumed coefficients and the resulting harvester full utilization acreage per year is presented in Tables 13 and 14. These estimates of full utilization in terms of acres per year is then divided into the smallest and largest enterprise size within the size category measured in terms of planted acres for the selected commodities and acres as presented in Table 9. The result is a range in the number of harvesters needed for that size category used at full capacity. If the range includes an integer such as 1, 2, 3, etc., then it is assumed that the size category is "a least-cost enterprise size." A least-cost enterprise size is a size category in which it is possible to use one or more harvesters at or near full capacity within the size category without increasing or decreasing planted acres enough to move into another size category. This measure of full utilization of harvesting machinery is the means used to determine whether representative enterprise can spread the cost of specialized durables over the least-cost units of output. Further we can assume that a representative enterprise within a least-cost enterprise size is capable of operating at the least-cost point on its short-run average cost curve.

2.5 The Survivor Technique and the Herfindahl Index

The cost of production and proportion of full utilization of harvesting machinery are attempts to measure relative efficiency of enterprises by size. These measures do not by themselves assure an accurate estimate of potential efficiency attainable by enterprises of various size and type. At any point in time, there is a wide array of producers some of whom are producing a commodity efficiently and

Table 13. Engineering Coefficients Associated with the Harvesters for the Selected Field Crops Used to Determine the Extent Utilization in Acres Per Year.

Harvester	Corn	Soybeans		Wheat		Rice	
Description	IL/IN/IO/NE	IL/IO/OH	MS	KS/MT/ND/WA	WA[1/]	CA/TX	DLT/AK
Type	SP. 6-R	SP. 6-R	SP. 8-R	SP."regular"	SP."hillside"	SP. track	SP. sm. grain
Width (ft)	18	15	19	20	13	16	17
Speed (mph)	3	3	3.3	3	3	1	1
Efficiency (%)	70	70	70	70	70	60	60
Total hours (hr)	2000	2000	2000	2000	2000	3500	3500
Useful life (yr)	20	20	13.3	20	20	8.75	8.75
Acres/yr.	458	382	798	509	458	465	495

[1/] Washington area 400 wheat assumed harvested on average by a self-propelled "regular" and "hillside" harvester in 70/30 proportion respectively for a composite harvester full utilization of 494 acres per year.

Source of Data: U.S. Dept. of Agriculture, Firm Enterprise Data System, Machinery Compliments from "1983 FEDS Crop Budgets" by Ron Krenz and Gail Garst, unpublished.

Table 14. Engineering Coefficients Associated wtih the Cotton Harvesters Used to Determine the Extent of Utilization in Acres Per Year.

Harvester Description	Cotton				
	AL	CA	MS	TX1/	TX2/
Type	SP-2R-pick	SP-2R-pick	SP-2R-pick	SP-4R-strip	mtd.-2R-strip
Width (ft)	6.7	6.7	6.7	12	6.7
Speed (mph)	3.9	4.6	3.8	4.3	5.1
Efficiency (%)	70	75	70	75	75
Total hours (hrs)	2500	2500	2500	2000	2000
Useful life (yrs)	14.3	15.2	14.3	13.8	16.7
Acres/yr	388	462	378	680	373

1/ Texas area 200 irrigated cotton assumed harvested on average by a self-propelled 4-row and mounted 2-row stripper in 50/50 proportion respectively for a composite harvester full utilization of 527 acres per year.

2/ Texas area 200 dry land cotton assumed harvested on average by a self-propelled 4-row and mounted 2-row stripper in 33/67 proportion respectively for a composite harvester full utilization of 474 acres per year.

Source of Data: Ron Krenz and Gail Garst, "1983 FEDS Crop Budgets" with associated machinery compliments, unpublished.

others who are not. The distribution of producers' efficiency by size is unknown. The survivor technique is useful in providing information as to which enterprise sizes are attracting the more efficient producers.

The survivor technique is based on the premise that producers themselves are intimately familar with the array of possible production technologies and practices and that over time they tend to survive by moving toward the least-cost means of production which includes the least-cost enterprise size." The [survivor technique's] fundamental postulate is that the competition of different sizes of firms sifts out the more efficient enterprise" (Stigler, 1958, p. 55). This approach is intuitively appealing in its simplicity. The survivor technique is subject to the criticism associated with pure induction in that it is correlation without causation. The empirically estimated size-efficiency relationship may be the result of other factors unrelated to economies of size. However, the survivor technique can provide useful corraborative evidence when "... used in conjunction with the more incisive types of cost analysis" such as cost of production and full utilization of harvesting machinery (Madden, 1967, p. 26).

Stigler defines the efficient firm as

> ... one that meets any and all problems the entrepreneur actually faces: strained labor relations, rapid innovation, government regulation, unstable foreign markets, and what not. This is, of course, the decisive meaning of efficiency from the point of view of the enterprise (1958, p. 56).

Stigler defines the procedure used to estimate the efficient enterprise size using the survivor technique as follows:

> Classify the firms in an industry by size, and calculate the share of industry output coming from each class over time. If the share of a given class falls, it is relatively inefficient, and in general is more inefficient the more rapidly the share falls. (1958, p. 56).

As with the other economies-of-size estimation procedures, the survivor technique presumes that enterprises with different initial resource endowments will have a different least-cost enterprise size. Conversely enterprises with similar initial resource endowments will coverge toward a single least-cost enterprise size. (Stigler, 1958, p. 57).

The data required to estimate the most efficient enterprise size using the survivor technique include the number of enterprises and the production of these enterprises by size category for the selected commodities in an area at two or more points in time. The U.S. Department of Commerce's 1982 Census of Agriculture provides a state level classification of the number and total production of field crop enterprises for 1978 and 1982 by enterprise size. This information is listed in the 1982 Census of Agriculture under the title "Specified Crops by Acres Harvested: 1982 and 1978." There are eight enterprise size categories listed across all commodities. The enterprise size categories include:

(1) 1 to 14 acres
(2) 15 to 24
(3) 25 to 49
(4) 50 to 99
(5) 100 to 249
(6) 250 to 499
(7) 500 to 999
(8) 1000 acres or more

In this study, we are only concerned with categories (4) through (8) depending on the commodity and production area under consideration.

These latter size categories are matched to correspond as nearly as possible with the planted acre arrays associated with very large, large and medium enterprised derived from the FEDS data.

A variation of the Herfindahl index is used to measure the share of industry output. The Herfindahl index is adapted from its originally intended use as a measure of concentration found in the industrial organization literature. The Herfindahl index is defined as the sum of squares of a firms market share in an industry. This index is described as

> ...an excellent measure of static size structure for two basic reasons. The first is that it is sensitive and takes into account the complete size distribution of firms. The second is that it incorporates both of the two static size structural features...the smallness of the number of firms and the variation among sizes of the firms... The Herfindahl Index increases with either greater variation in the sizes of the firms...or with a smaller number of firms (Grossack, 1965, p. 302).

The equation for the Herfindahl index is

$$(3) \quad HI_{X_t} = \sum_{i=1}^{n} X_{it}^2$$

where

$$X_{it} = \frac{Q_{it}}{\sum_{i=1}^{n} Q_{it}}$$

and HI_{X_t} is the Herfindahl index for industry x at time t

n is the number of firms in industry X

X_{it} is the market share measured in terms of production of the i^{th} firm in industry X at time t

Q_{it} is the quantity of the i^{th} firm at time t.

The Herfindahl index is a measure of concentration that increases as the variation in relative production among different size firms increases. As an industry moves toward a monopoly, the Herfindahl index increases to a maximum of one. As the degree of competition increases in an industry with n firms producing an equal share of production, the Herfindahl index decreases toward 1/n. We can use the 1982 Census of Agriculture data in conjunction with the "summands" of the Herfindahl index to provide an estimate of relative concentration of production within a production area by enterprise size.

Equation (3) can be rewritten in a more aggregated form which is consistent with the way it would be calculated using the available Census of Agriculture data. Since we have information only by size categories rather than by enterprises for individual farms, the more aggregated form of equation (3) is

$$(4) \quad HI_{X_t} = \sum_{j=1}^{N} \left[\frac{(\sum_{i=1}^{n} X_{ij})^2}{n} \right]$$

$$\text{where } \sum_{i=1}^{n} X_{ijt} = \frac{Q_{jt}}{\sum_{j=1}^{N} Q_{jt}}$$

and HI_{X_t} is the same as defined above

X_{ijt} is the market share measured in terms of production of the i^{th} firm in the j^{th} size class at time t

n is the number of firms in the j^{th} size class

Q_{jt} is the quantity of production of the j^{th} size class at time t

N is the number size classes in industry x at time t.

Q_{jt}, $\sum_{j=1}^{N} Q_{jt}$, n and N is the information published in the Census of Agriculture. This reformulation of the original Herfindahl index is consistent as long as we agree to the necessary simplifying assumption. Equations (3) and (4) have the following relationship.

$$(5) \quad \sum_{i=1}^{n} X_i^2 = \frac{\left(\sum_{i=1}^{n} X_i\right)^2}{n} + \sum_{i=1}^{n} (X_i - \overline{X})^2$$

(Massey and Dixon, 1969, p. 28.).

The expression $\sum_{i=1}^{n} (X_i - \overline{X})^2$ is the variance or mean-square deviation multiplied by n-1. We can make one of two simplifying assumptions given that we lack enterprise level data to resolve this difference between these two expressions. If we assume that all enterprise's market share are equal such that all X_i's equal $\overline{X}$ then the expression $\sum_{i=1}^{n} (X_i - \overline{X})^2$ equals zero. Unfortunately this assumption also implies that the industry is completely competitive with all enterprises of equal size with an associated Herfindahl index of 1/n.

Alternatively, since the information from the Census of Agriculture is classified by enterprise size, we can assume that the variance across size categories is constant such that the expression $\sum_{i=1}^{n} (X_{ij} - \overline{X}_j)^2$ equals a constant. Equation (5) can be rewritten so that

$$(6) \quad \sum_{h=1}^{N} \sum_{i=1}^{n} X_{ij}^2 = \sum_{j=1}^{N} \frac{\left(\sum_{i=1}^{n} X_{ij}\right)^2}{n} + \sum_{j=1}^{N} C_j$$

where $C_j = \sum_{i=1}^{n} (X_{ij} - \overline{X}_j)^2$ and is equal across all size classes. With the assumption of constant variance across class size, equation (4) is a consistent though biased estimate of equation (3). The bias is positive and equal to the variance within the class size multiplied by (n-1).

As stated above, we are not interested in the Herfindahl index per se but rather in the "summands" associated with the index. In particular we are interested in the expressiong $((\sum_{i=1}^{n} X_{ijt})^2)/n$. Each summand can be defined as the relative Herfindahl index (RHI) and used to measure the share of industry output by size class as required by Stigler's survivor technique.

$$(7)\quad \text{RHI} = ((\sum_{i=1}^{n} X_{ijt})^2)/n = ((Q_{ij}/\sum_{j=1}^{N} Q_{jt})^2)/n.$$

Equation (7) has the following characteristics as a measure of the share of industry output. It is sensitive to enterprise number and production. It takes into account only the size distribution of enterprises within the size class. The RHI decreases with an increase in the number of enterprises and increases with an increase in the share of production in the size class. The RHI suggests the relative contribution of the size class to the production for this industry at a given point in time. Finally and most importantly the array of RHI's for an industry within a state suggests the relative concentration of production across size class at a given point in time. This array of RHI's represents a static measure of the survivor technique. Tables 15 and 16 include the 1978 and 1982 static relative Herfindahl indices for the selected commodities and production areas by enterprise size respectively.

In addition to a static measure of relative concentration of production, it is also useful to know the change in relative concentration of production through time. It is necessary to have a dynamic measure of relative production concentration in order to apply the decision rules of the survivor technique. Madden states these decision rules as follows:

> Size classes that exhibit a declining proportion of the industry's capacity through time are deemed to be inefficient. Conversely, an increasing proportion of an industry's in a large size class is taken as prima facie evidence of efficiency and the attainment of economies of size. (1976, p. 25).

Grossack suggests a simple dynamic measure of using the ratio of Herfindahl indices at different points in time. (1965, p. 304).

A ratio of Herfindahl indices describes the percentage change in production concentration relative to some base period in time. Potentially, a set of dynamic concentration measures can be devised to provide information not only on the most efficient enterprise size but also on the process of productive reallocation among the various size classes (Grossack, 1965, p. 304). We will focus our attention on the former. The dynamic measure of production concentration as proposed by Grossack is present as follows

(8) $C(HI) = HI_y/HI_x$ (1965, p. 303-304)

where $C(HI)$ is the change in the production concentration at point in time y relative to a base period in time x

HI_y is the Herfindahl index at time y

HI_x is the Herfindahl index at time y.

We are interested in the relative Herfindahl index however, so with that in mind a modest revision of equation (8) can be rewritten as follows:

Table 15. The 1978 Herfindahl Indices for the Selected Production Areas for the Respective Commodities by Enterprise Size and State

Enterprise Size (acres)	Corn		Soybeans		Wheat		Rice		Cotton	
	Size (acres)	Herfindahl Index 1/	Size (acres)	Herfindahl Index 1/	Size (acres)	Herfindahl Index 1/	Size (acres)	Herfindahl Index 1/	Size (acres)	Herfindahl Index 1/
	IL 300		IL 300		KS 100		CA 400*		AL 600	
VL	500+	1510-8	999-500	580-8	1000+	1950-8	1000+	137,030-8	1000+	70,031-8
L	499-250	970-8	999-250	1030-8	1000+	1950-8	1000+	137,030-8	999-500	67,160-8
M	249-100	520-8	249-100	700-8	999-500	1830-8	999-500	40,000-8	999-500	67,160-8
Total	+500-100	3000-8	999-100	2310-8	+1000-500	3780-8	164,040-8	177,030-8	+1000-500	137,191-8
	IN 101		IO 201		MT 200		TX 1001*		CA 500*	
VL	1000+	1570-8	999-500	330-8	1000+	13,730-8	1000+	63,390-8	1000+	97,580-8
L	999-500	1630-8	499-250	750-8	999-500	4,320-8	1000+	63,390-8	1000+	97,580-8
M	499-250	1480-8	249-100	920-8	499-250	1,320-8	999-500	40,990-8	999-500	7,900-8
Total	+1000-250	4680-8	999-100	2000-8	+1000-250	19,370-8	+1000-500	104,380-8	+1000-500	105,480-8
	IO 201		MS 100		ND 200		DLT 100-300*		MS 100	
VL	999-500	400-8	1000+	20,280-8	1000+	2070-8	1000+	142,260-8	1000+	39,480-8
L	499-250	630-8	999-500	4,710-8	999-500	1970-8	999-500	99,420-8	1000+	39,480-8
M	249-100	560-8	999-500	4,710-8	499-250	1200-8	499-250	48,910-8	999-500	19,280-8
Total	999-100	1590-8	1000-500	24,990-8	+1000-250	5240-8	+1000-250	290,590-8	+1000-500	58,760-8
	NE 400*		OH 101		WA 400		AK 200*		TX 200*	
VL	1000+	3600-8	999-500	1340-8	1000+	21,650-8	1000+	+111570-8	1000+	9,150-8
L	999-500	2840-8	499-250	1880-8	1000+	21,650-8	999-500	14,730-8	999-500	6,320-8
M	499-250	2240-8	249-100	1470-8	999-500	7,150-8	499-250	9,960-8	499-250	3,120-8
Total	+1000-250	8680-8	999-100	4690-8	+1000-500	28,800-8	+1000-250	36,260-8	+1000-250	18,590-8
									TX 200	
VL									1000+	13,080-8
L									1000+	13,080-8
M									999-500	6,740-8
Total									+1000-500	19,820-8

* Irrigated

1/ Scientific notation (-8) means to move the decimal point eight places to the left.

Source of Data: U.S. Dept. of Commerce, 1982 Census of Agriculture, State Data, Table 41, "Specified Crops by Acres Harvested: 1982 and 1978" for respective states.

Table 16. The 1982 Herfindahl Indices for the Selected Production Areas for the Respective Commodities by Enterprise Size and State

Enterprise Size	Corn		Soybeans		Wheat		Rice		Cotton	
	Size (acres)	Herfindahl Index 1/	Size (acres)	Herfindahl Index 1/	Size (acres)	Herfindahl Index 1/	Size (acres)	Herfindahl Index 1/	Size (acres)	Herfindahl Index 1/
	IL 300		IL 300		KS 100		CA 400*		AL 600	
VL	500+	2020-8	999-500	840-8	1000+	2280-8	1000+	131,640-8	1000+	114,290-8
L	499-250	970-8	499-250	1190-8	1000+	2280-8	1000+	131,630-8	999-500	72,800-8
M	249-100	440-8	249-100	670-8	999-500	1710-8	999-500	32,400-8	999-500	72,800-8
Total	+500-100	3430-8	999-100	2700-8	+1000-500	3990-8	+1000-500	164,040-8	+1000-500	187.090-8
	IN 101		IO 201		MT 200		TX 1001*		CA 500*	
VL	1000+	2080-8	999-500	440-8	1000+	16,480-8	1000+	81,000-8	1000+	135,650-8
L	999-500	1980-8	499-250	890-8	999-500	3,800-8	1000+	81,000-8	1000+	135,650-8
M	499-250	1640-8	249-100	870-8	499-250	910-8	999-500	49,280-8	999-500	8,650-8
Total	+1000-250	5700-8	999-100	2200-8	+1000-250	21,190-8	+1000-500	130,280-8	+1000-500	144,280-8
	IO 201		MS 100		ND 200		DLT 100-300*		MS 100	
VL	999-500	590-8	1000+	22,120-8	1000+	3,040-8	1000+	93,750-8	1000+	48,910-8
L	499-250	700-8	999-500	5,210-8	999-500	2,190-8	999-500	80,100-8	1000+	48,910-8
M	249-100	500-8	999-500	5,210-8	499-250	1,100-8	499-250	54,110-8	999-500	23,330-8
Total	999-100	1790-8	1000-500	27,330-8	+1000-250	6,330-8	+1000-250	227,960-8	+1000-500	72,240-8
	NE 400*		OH 101		WA 400		AK 200*		TX 200*	
VL	1000+	5100-8	999-500	1970-8	1000+	22,380-8	1000+	13,980-8	1000+	16,210-8
L	999-500	3140-8	499-250	2270-8	1000+	22,380-8	999-500	11,720-8	999-500	11,360-8
M	499-200	2190-8	249-100	1430-8	999-500	7,040-8	499-250	9,300-8	499-250	5,610-8
Total	+1000-200	10430-8	999-100	5670-8	+1000-500	29,420-8	+1000-250	35,000-8	+1000-250	33,180-8
									TX 200	
VL									1000+	13,920-8
L									1000+	13,920-8
M									999-500	7,060-8
Total									+1000-500	20,980-8

* Irrigated

1/ Scientific notation (-8) means to move the decimal point eight places to the left.

Source of Data: U.S. Dept. of Commerce, 1982 Census of Agriculture, State Data, Table 41, "Specified Crops by Acres Harvested: 1982 and 1978" for respective states.

$$(9)\quad C(RHI) = RHI_y/RHI_x = [(Q_{jy}/\sum_{j=1}^{N} Q_{jy})^2/n_y] \div [(Q_{jx}/\sum_{j=1}^{N} Q_{jx})^2/n_x].$$

Equation (9) has the same characteristics as equation (7). In addition, the C(RHI) provides information as to the change in the relative concentration of the size class to the production for this industry between time periods x and y. Furthermore an array of C(RHI)'s for an industry within a state provides information on the change in relative production concentration across size class between time periods x and y. This dynamic array of relative production concentration is a second measure of the survivor technique. We have assumed in this study that the base period is 1978 and the change in relative production concentration by enterprise size is compared to that recorded in 1982.

2.6 Commodity Analysis and Scoring Table

The next five sections of this study involve the presentation and discussion of the above defined measures of size economies as well as a discussion of comparative advantage in the production of corn, soybeans, wheat, rice and cotton, respectively, in the selected areas of the U.S. The first subsection deals with size economies and includes a summary of the average costs and full utilization of harvesting machinery as well as static and dynamic relative Herfindahl indices used to determine relative efficiency by enterprise size. In addition, this subsection includes an analysis of yields and various types of disaggregated costs by enterprise. The objective of this analysis is to determine the source or explain the absence of technological internal economies of size in each of the selected commodity producing areas.

The second subsection for each of these commodities deals with comparative advantage and its relationship to internal size economies. This subsection includes a summary of average costs, the extent of internal economies, relative enterprise size as well as static and dynamic Herfindahl indices used to determine relative efficiency by production area. As with the subsection on size economies this subsection includes an analysis of yield and various types of production costs now aggregated for the production area rather than by enterprise. Land costs are included in the production cost analysis. The primary objective in presenting comparative advantage information is to provide a context within which to analyze size economies. An additional objective is to determine the source or explain the absence of comparative advantage.

There is one final methodological issue that deserves attention before we turn our attention to the commodity sections. As was stated in the introduction of this section, we have selected four different measures and techniques to be "used as evidence in building a case regarding the existence of size economies for the various commodities." The question remains as to "how do we know when we have sufficient evidence to make such a case?" The measures themselves refer to average costs, full utilization of harvesting machinery and two types of Herfindahl indices. A summary of these measures is provided by enterprise size in each commodity section. There is an element of judgment required in using these indices. To clarify and facilitate the judgment used, a scoring table was set up and marked for each of the measurement categories. Each enterprise within a category is given a plus or minus for the presence or absence respectively of a "clear advantage" which one enterprise exhibits relative to the others within a given production area. Each measurement category is weighted equally so that the overall or total measure of size economies is expressed as the sum of the pluses. The range in the scoring is from 0 to 4. Zero implies no advantage for the enterprise size. Four implies a clear advantage for an enterprise size relative to one or both of the enterprise sizes within a production area. This scoring table immediately follows the summary of the measures within each commodity section.

With this in mind, we turn next to an analysis of size economies and comparative advantage in the production of corn.

CHAPTER III

CORN

This section presents the particulars associated with size economies within and comparative advantage among the selected commercial corn-for-grain producing areas. The producing areas are:

(1) Illinois area 300
(2) Indiana area 101
(3) Iowa area 201
(4) Nebraska area 400 - irrigated

For these corn-producing areas, an analysis of size economies and comparative advantage is presented in terms of cost-of-production data and other estimated indices.

3.1 Size Economies in Corn Production

The four measures or indicators of size economies are estimated according to the procedures outlined in the section on methodology. These indicators include production costs, utilization of harvesting machinery as well as static and dynamic Herfindahl production concentration indices. A summary of these indices is presented in Table 17 by enterprise size for each of the selected production areas. Table 18 presents the results of the scoring procedure.

In Illinois area 300, the very large corn enterprises have a cost advantage and they can fully utilize 1 or more self-propelled 6-row harvesters. These harvesters are assumed to have an annual harvesting

Table 17. Indices Used to Determine Size Economies in the Selected Corn Producing Areas in 1983.

State, Area & Enterprise Size	Average Total Cost Per Bushel %	Enterprise Size in 1983 Acres		Harvest Machinery Full Utilization		Herfindahl Indices	
		Mean	S.D.	Max	Min	Static[1/] %	Dynamic[2/] %
IL 300							
VL	100	1113	961	5.4	.9	100	35
L	103	355	50	.9	.7	96	0
M	112	246	29	.6	.5	43	-15
IN 101							
VL	100	903	86	2.1	1.7	100	32
L	100	515	71	1.4	.9	95	21
M	104	273	83	.9	.4	79	11
IO 201							
VL	100	576	196	1.8	1.0	100	48
L	104	249	30	.6	.5	118	11
M	105	170	32	.5	.3	85	-11
NE 400*							
VL	100	1715	608	5.2	2.6	100	42
L	111	671	267	2.1	.9	62	11
M	117	266	54	.8	.5	43	- 2

1/ 1982 absolute Herfindahl measure is normalized using the very large size as the base.

2/ 1978 and 1982 Herfindahl indices are used to measure the change in concentration. This change can results from movement within and between size categories.

* Irrigated.

capacity of about 450 acres per harvester. The static relative Herfindahl index which is the measure of relative production concentration in 1982, is greatest for very large and large enterprises. The dynamic relative Herfindahl index which is the change in relative concentration from 1978 to 1982 is positive only for the very large enterprise size. Productive resources in Illinois area 300 appear to

Table 18. Scoring Table Used to Determine Size Economies in the Selected Corn Producing Areas in 1983.

State, Area & Enterprise Size	Production Cost	Harvester Utilization	Herfindahl Indices		Total
			Static	Dynamic	
IL 300					
VL	+	+	+	+	4
L	-	-	+	-	1
M	-	-	-	-	0
IN 101					
VL	+	+	+	+	4
L	+	+	+	+	4
M	-	-	+	+	2
IO 201					
VL	+	+	+	+	4
L	-	-	+	+	2
M	-	-	+	-	1
NE 400*					
VL	+	+	+	+	4
L	-	+	-	+	2
M	-	-	-	-	0

* Irrigated.

be concentrating in the very large enterprise size in part by drawing resources away from the medium and small (those below the 40th decile in size) enterprise sizes. The scoring results are 4-1-0 for the very large, large and medium size enterprises respectively. There is strong evidence to argue for the existence of size economies for very large enterprises relative to large and medium enterprises in corn production in Illinois area 300.

In Indiana area 101, very large and large enterprises have nearly identical costs per bushel. Very large enterprises can fully utilize 2, and large enterprises can fully utilize 1 self-propelled 6-row harvester(s). The relative production concentration in 1982 is greatest for very large and large enterprises. The dynamic concentration index is positive for all three enterprise sizes.

Productive resources in Indiana area 101 appear to be concentrating in the very large and large enterprise size at the expense of smaller enterprises. The scoring results are 4-4-2 for the very large, large and medium enterprises respectively. There is evidence to argue that size economies exist for very large and large enterprises relative to the medium-size enterprise in corn production in Indiana area 101.

In Iowa area 201, very large corn enterprises have a cost advantage and they can fully utilize 1 to 2 self-propelled 6-row corn harvesters. The static production concentration in 1982 is greatest for large enterprises however. The change in relative production concentration from 1978 to 1982 is positive for very large and large enterprises in this area. Productive resources in Iowa area 201 appear to be concentrating in very large and large enterprises at the expense of medium-size enterprises. The scoring results are 4-2-1 for very large, large and medium enterprises respectively. There is evidence to argue that size economies exist for very large enterprises relative to large and medium (and probably from the small) enterprises in corn production in Iowa area 201.

In Nebraska area 400, very large irrigated corn enterprises have a production cost advantage. Very large and large enterprises can fully utilize 3 to 5 and large enterprises, 1 to 2 self-propelled 6-row harvesters. Static production concentration is greatest for very large enterprises. The change in relative production concentration from 1978 to 1982 is positive for very large and large enterprises in this area. Productive resources in Nebraska area 400 appear to be concentrating in very large and large enterprises at the expense of medium enterprises. The scoring results are 4-2-0 for very

Table 19. Production Costs and Yield by Enterprise Size in the Selected Corn Producing Areas in 1983.

State, Area & Enterprise Size	Average Total Cost1/		Yield2/		Total Cost1/	
	$/Bu	%	Bu/Acre	%	$/Acre	%
IL 300						
VL	1.67	100	130.3	100	217	100
L	1.75	105	128.6	99	225	103
M	1.99	119	123.1	94	245	113
IN 101						
VL	1.69	100	125.6	100	212	100
L	1.67	99	125.3	100	209	98
M	1.77	105	122.4	97	217	102
IO 201						
VL	1.67	100	119.0	100	199	100
L	1.80	107	117.4	99	211	106
M	1.75	105	113.0	95	198	99
NE 400*						
VL	2.83	100	118.6	100	336	100
L	3.03	107	112.6	95	341	102
M	3.21	113	106.2	90	341	102

1/ Excluding land charges.

2/ 1982 state level yields per harvested acre for irrigated and non-irrigated.

* Irrigated.

large, large and medium enterprises respectively. There is clear evidence to argue that size economies exist for very large enterprises in irrigated corn production in Nebraska area 400.

A more detailed examination of the components of the production cost measures provides a better understanding of the source of size economies. Total cost per unit is equal to total cost per acre divided by yield per acre. Table 19 summarizes production costs and yields by enterprise size in the selected corn producing areas. Very large enterprises in general tend to have the lowest total cost per

Table 20. Preharvest, Harvest and Capital Ownership Costs by Enterprise Size in the Selected Corn Producing Areas in 1983.

State, Area & Enterprise Size	Total Costs		Preharvest		Harvest		Ownership	
	$/Acre	%	$/Acre	%	$/Acre	%	$/Acre	%
IL 300								
VL	217	100	147	100	28	100	42	100
L	225	103	153	104	28	100	44	105
M	245	113	171	116	28	100	46	110
IN 101								
VL	212	100	144	100	27	100	41	100
L	209	98	139	97	27	100	43	105
M	217	102	147	102	27	100	43	105
IO 201								
VL	199	100	134	100	33	100	32	100
L	211	106	140	104	30	91	41	128
M	198	99	124	93	28	85	46	144
NE 400*								
VL	336	100	203	100	34	100	99	100
L	341	102	208	102	34	100	99	100
M	341	102	203	100	34	100	104	105

* Irrigated

bushel. Very large and large enterprises all have at least slightly higher yields per acre relative to medium size enterprises. Thus, yield is a source of size economies in corn production. Total costs per acre are relatively uniform across enterprise size except in Illinois area 300 in which very large and large enterprises have a cost advantage over the medium size enterprise.

Total costs per acre can be disaggregated into preharvest, harvest and capital ownership costs. See Table 20. Preharvest costs per acre are substantially less for very large and large enterprises in Illinois area 300. Preharvest costs are nearly uniform across enterprises in Indiana area 101 and Nebraska area 400 (irrigated). In Iowa area 200, medium enterprises have the lowest preharvest costs per acre. Variable harvest costs are uniform across enterprise sizes in all the selected corn producing areas except Iowa area 201. The difference in variable harvest costs in Iowa area 201 is related to the substantial use of custom harvesting by very large and large enterprises. Capital ownership costs are nearly uniform across enterprise sizes with a slight advantage for very large enterprises in all the selected corn producing areas except Iowa area 201. In Iowa area 201, the very large enterprises have a substantial capital ownership cost advantage relative to both large and medium enterprises. In general, capital ownership costs represents a source of size economies in corn production in the selected corn producing areas.

Preharvest costs can be disaggregated into associated cost components to get yet a clearer picture of the relative costs between enterprise sizes within a given corn producing area. See Table 21. In Illinois area 300, very large and large enterprises have lower expenditures per acre on fertilizer than do medium enterprises. The very large enterprises have lower expenditures on fuel, repairs and labor relative to large and medium enterprises. In Indiana area 101, very large enterprises have slightly higher expenditures per acre on herbicides and insecticides while having slightly lower expenditures on fuel, repairs and labor relative to large and medium enterprises. In Iowa area 201, very large enterprises have higher fertilizer and insecticide expenditures especially in relation to medium enterprises while having lower fuel, repairs and labor expenses relative to larger and medium enterprises. In Nebraska area 400, very large enterprises have higher herbicide and insecticide expenditures and lower fuel, lubrication, repairs and labor expenditure particularly in relation to

Table 21. Preharvest Variable Costs Per Acre in Determining Size Economies in the Selected Corn Producing Areas in 1983.

	Enterprise	Illinois 300		Indiana 101		Iowa 201 291		Nebraska 400*	
		$/Acre	Diff[1]	$/Acre	Diff[1]	$/Acre	Diff[1]	$/Acre	Diff[1]
Seed	VL	18	0	19	0	18	0	19	0
	L	19	1	17	-2	18	0	22	3
	M	18	0	18	-1	18	0	18	-1
Fertilizer	VL	73	0	64	0	62	0	40	0
	L	74	1	61	-3	67	5	41	1
	M	81	8	69	5	53	-9	39	-1
Herbicides & Insecticides	VL	20	0	25	0	19	0	23	0
	L	18	-2	20	-5	15	-4	22	-1
	M	24	4	21	-4	13	-6	17	-6
Fuel, Lubrication, Repairs & Labor	VL	14	0	13	0	15	0	19	0
	L	19	5	17	4	20	5	19	0
	M	23	9	16	3	20	5	25	6
Other	VL	6	0	9	0	6	0	83	0
	L	7	1	9	0	6	0	85	2
	M	9	3	8	-1	6	0	85	2
General Farm Overhead	VL	16	0	15	0	14	0	19	0
	L	16	0	15	0	14	0	19	0
	M	16	0	15	0	14	0	19	0
Total	VL	147	0	145	0	134	0	203	0
	L	153	6	139	-6	140	6	208	5
	M	171	24	147	2	124	-10	203	0

[1] Difference between the very large enterprise cost and the cost associated with either the large or the medium size enterprises.

medium size enterprises. Preharvest variable costs associated with machinery and tractors is considerably lower for the very large enterprise relative to large and medium enterprises in each of the selected corn producing areas. These lower expenditures on fuel, lubrication, repairs and machinery labor imply some combination of larger and more efficient machines and also that tractors go over each acre of land fewer times.

Capital ownership costs can also be disaggregated into associated cost components. See Table 22. Capital ownership costs are defined as depreciation, insurance, taxes and interest (opportunity costs) on machinery and tractors used in land preparation, cultivation and planting, fertilizer and chemical application, irrigation, harvesting and hauling. In Illinois area 300, Indiana area 101 and Nebraska area 400, these ownership costs are nearly uniform across enterprise size varying by \$2/acre or less. In Iowa area 201 harvesting ownership costs vary by as much as \$12/acre depending on enterprise size. The reason for the difference in harvesting ownership cost is because 33% and 20% of the corn on very large and large enterprises respectively, were custom harvested in this area in 1983. See Table 23. Custom harvesting represents a source of pecuniary size economy in Iowa area 201.

Harvesting is the single most costly capital ownership item in each of the selected corn producing areas except Nebraska area 400. It is assumed that the corn is harvested in each area on each enterprise by one or more self-propelled six-row corn harvesters. Harvesting ownership cost is assumed constant across enterprise size adjusted for the percent of custom harvesting. Recall, however, that the extent of utilization of harvesting equipment is one of the four

Table 22. Ownership Costs Per Acre in Determining Size Economies in the Selected Corn Producing Areas in 1983.

Field Operation	Enterprise Size	Illinois 300		Indiana 101		Iowa 201		Nebraska 400	
		$/Acre	$ Diff[1]	$/Acre	$ Diff[1]	$/Acre	$ Diff[1]	$/Acre	$ Diff[1]
Land Preparation	VL	4	0	4	0	3	0	5	0
	L	4	0	5	1	4	1	3	-2
	M	5	1	4	0	4	1	4	-1
Planting & Cultivation	VL	2	0	1	0	4	0	2	0
	L	2	0	2	1	4	0	3	1
	M	2	0	2	1	3	-1	4	2
Fertilizer & Chemicals Application	VL	2	0	2	0	1	0	1	0
	L	3	1	1	-1	2	1	2	1
	M	2	0	2	0	2	1	2	1
Irrigation	VL	0	0	0	0	0	0	44	0
	L	0	0	0	0	0	0	44	0
	M	0	0	0	0	0	0	46	2
Harvesting	VL	27	0	27	0	15	0	29	0
	L	27	0	27	0	21	6	29	0
	M	27	0	27	0	27	12	29	0
Hauling	VL	7	0	7	0	9	0	18	0
	L	8	1	8	1	10	1	18	0
	M	10	3	8	1	10	1	18	1
Total	VL	42	0	41	0	32	0	99	0
	L	44	2	43	2	41	9	99	0
	M	46	4	43	2	46	14	104	5

[1] Difference between very large enterprise cost and the costs associated with either the large or medium size enterprises.

Table 23. Harvesting Costs Per Acre in the Selected Corn Producing Areas in 1983.

State, Area & Enterprise Size	Custom Harvested		Producer Harvested[1/]		Total Harvest Cost	
	%	$/acre	%	$/acre	%	$/acre
IL 300						
VL	0	0	100	35.45	100	35.45
L	0	0	100	35.45	100	35.45
M	0	0	99	35.46	99	35.46
IN 101						
VL	0	0	100	35.35	100	35.35
L	0	0	100	35.35	100	35.35
M	0	0	100	35.35	100	35.35
IO 201						
VL	33	22.58	66	30.45	99	27.83
L	20	18.30	80	35.30	100	31.90
M	0	0	100	35.30	100	35.30
NE 400						
VL	0	0	100	37.27	100	37.27
L	0	0	100	37.27	100	37.27
M	0	0	100	37.25	100	37.27

[1/] Includes fuel, lubrication, repairs, labor and ownership costs.

indices of size economies. Therefore, it is assumed that full utilization of discrete units of harvesting equipment is a source of size economies in each of the selected corn producing areas.

In Nebraska area 400, ownership costs for irrigation (wells and equipment) represents the most costly capital ownership item. See Table 24. It is assumed that each enterprise size in this area has the same total cost per acre including the same ownership cost associated with well pumped irrigation water. Purchased water is substantially cheaper but is very limited in supply in this area and therefore, does not represent a major source of pecuniary size diseconomies.

In summary it appears that the source of size economies in the selected corn producing areas are as follows. In Illinois area 300,

Table 24. Irrigation Costs in the Selected Corn Producing Areas in 1983.

State, Area & Enterprise Size Size	Purchased Water		Well Pumped Water 1/		Total Water	
	acre-inch	$/acre-inch	acre-inch	$/acre-inch	acre-inch	$/acre-inch
IL 300						
VL	0	0	0	0	0	0
L	0	0	0	0	0	0
M	0	0	0	0	0	0
IN 101						
VL	0	0	0	0	0	0
L	0	0	0	0	0	0
M	0	0	0	0	0	0
IO 201						
VL	0	0	0	0	0	0
L	0	0	0	0	0	0
M	0	0	0	0	0	0
NE 400						
VL	0	0	14.4	7.61	14.4	7.61
L	.9	1.23	14.4	7.61	15.3	7.23
M	.9	1.14	14.9	7.61	15.8	7.24

1/ Includes fuel, lubrication, repairs, and capital ownership cost.

yield is a source of size economies. The very large enterprises in this area also have lower expenditures per acre on fertilizer, fuel lubrication, repairs and labor relative to large and medium enterprises. In Indiana area 101, yield is also a source of size economy. Preharvest and ownership costs are not a source of size economies in this area. In Iowa area 201, yield is again a source of size economy as is custom harvesting. In Nebraska area 400, yield is a source of size economies. Purchased irrigation water also represents a potential for size diseconomies. Very large enterprises in each of the selected producing areas consistently have slightly lower variable and ownership costs associated with tractors and machinery. This implies that very large corn enterprises tend to use some combination of fewer and/or more efficient machines and tractors which go over the field fewer times. This is a consistent source of size economies in the selected corn producing areas.

3.2 Comparative Advantage in Corn Production

In the previous section we focused our attention exclusively on size economies within a production area. In this section we shift our focus to the comparative advantage in corn production among areas. As described in the methodology section, production data by enterprise size are combined using the static relative Herfindahl index as a weight. To this information is added data on county level average land prices from the 1982 Census of Agriculture (COA). Yield information is changed from COA to the Statistical Reporting Service (SRS) data on county level yield per planted acre using a five year average. The overall objective for including comparative advantage is to provide a context within which to analyze size economies. The secondary objective of this subsection is to determine the source or explain the absence of comparative advantage between the selected production areas.

We begin by comparing the relationship between comparative advantage and size economies in the selected corn producing areas. See Table 25. The static Herfindahl index is the absolute measure of production concentration for the entire state. This static absolute index is equal to the sum of the static relative indices for the three enterprise size categories within the respective states. The dynamic Herfindahl index is a measure of the change in the static absolute measure between 1978 and 1982 for a particular state.

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Table 25. The Relationship Between Comparative Advantage and Size Economies in the Selected Corn Producing Areas in 1983.

Relative State & Area	Average Total Costs[1/]		Size Economies	Size Acres	Herfindal	
	$/Bu	%			Static Absolute[2/]	Dynamic %
IL 300	3.74	114	VL	653	3430-8	14
IN 101	3.61	110	VL&L	586	5700-8	22
IO 201	3.27	100	VL	335	1790-8	13
NE 400*	3.52	108	VL	1095	10430-8	20

1/ Includes a 10% rate of return to land.
2/ Scientific notation (-8) means to move the decimal point eight places to the left (eg. 3430-8 equals .00003430).

* Irrigated.

In Illinois area 300, the average total cost of corn production is about 14% higher than in Iowa area 201. In Illinois area 300, there are size economies for very large corn enterprise only. The average enterprise size is about 650 acres. This enterprise size can fully utilize a single self-propelled six-row harvester. The absolute measure of production concentration in this area is low compared to the Indiana area 101 and Nebraska area 400. This implies that corn production is not particularly concentrated in any one enterprise size category. Finally, between 1978 and 1982 production concentration has increased 14% overall or about 3.5% per year. This implies that size economies exist and producers are now beginning to exploit them as an option to increase their competitive position.

In Indiana area 101, the average total cost of producing corn is about 10% more than in Iowa area 201. In Indiana area 101, size economies exist for very large and large enterprises relative to medium size enterprises. The average enterprise size in this area is about

590 acres. This enterprise size can also fully utilize a single self-propelled six-row harvester. The absolute measure of production concentration in this area is greater than in Illinois area 300 and Iowa area 201. This implies that corn production is becoming concentrated in one or more enterprise size categories. And, between 1978 and 1982 production concentration increased 22% overall or 5.5%/year. This implies that producers are moving toward larger enterprise sizes in an effort to exploit size economies which exist in this area.

In Iowa area 201, the average total cost of producing corn is the lowest of the selected corn producing areas. Size economies exist in this area for very large enterprises relative to large and medium size enterprises. The average enterprise size is about 335 acres which is the lowest of the selected corn producing areas. This enterprise size can utilize a single self-propelled 6-row corn harvester rather fully. The absolute measure of production concentration is also the lowest of the selected producing areas. This implies that corn production is not concentrated in any one particular enterprise size in this area. Finally, between 1978 and 1982 production concentration increased 13% overall or about 3.3%./year. This implies that producers are beginning to exploit size economies and this option exists as a means of further reducing cost and enhancing comparative advantage.

In Nebraska area 400, the average total cost of producing irrigated corn is 8% higher than in Iowa area 201. In Nebraska area 400, size economies exist for very large enterprises relative to large and medium enterprises. The average enterprise size is about 1100 acres. This enterprise size can fully utilize about 2 self-propelled six-row harvesters. The absolute measure of production concentration in this

Table 26. Comparative Advantage in Corn Production in the Selected Areas in 1983.

State & Area	Average Total Cost[1]		Yield[2]		Total Cost[1]	
	$/Bu	%	Bu/Acre	%	$/Acre	%
IL 300	3.74	114	118.4	94	443	107
IN 101	3.61	110	108.3	86	391	95
IO 201	3.27	100	125.6	100	411	100
NE 400*	3.52	108	122.5	98	431	105

1/ Including a 10% land charge.
2/ Yield 1983-1979.

* Irrigated.

area is the highest of the selected corn producing areas. This implies that production is concentrated in one or more enterprise size categories. Finally, between 1978 and 1982 production concentration has increased 20% overall or 5%/year. This implies that producers are moving toward larger enterprise sizes in an effort to exploit size economies to enhance or maintain their competitive position.

Let us turn our attention now to the objective of determining the source or explaining the absence of comparative advantage between the selected corn-producing areas. The comparative advantage for a production area is based on the weighted average total production cost per unit of output of a representative enterprise constructed from the 40th through 90th deciles of enterprise sizes. The production costs and yield for these enterprises for the selected corn producing areas are presented in Table 26. These results indicate that Illinois area 300 has the highest total cost per bushel. Indiana area 101 and Nebraska area 400 have nearly identical total costs per bushel of corn. Iowa area 201 has the lowest total cost per bushel. On the basis of yield Iowa area 201 has the highest while Indiana area 101 has the lowest. On the basis of total cost per acre, Indiana area 101 has the lowest and Illinois area 300 has the highest.

The SRS data on yield per planted acre from 1972 to 1983 for these corn producing areas shows the relative changes in yield between the selected corn producing areas. See Table 27 and Figure 4. In Illinois area 300, the five year average corn yields between 1974 and 1981 increased at a rate of about .7% per year. This slow rate of growth in yield resulted in a decrease in relative yield in Illinois area 300 compared to Iowa area 201. In Indiana area 101, the five-year average corn yield between 1974 and 1981 increased at about 1.2% per year. This rate of growth in yield resulted in a decrease in relative yield in Indiana area 101 compared to Iowa area 201. In Iowa area 201, the five year average corn yield between 1974 and 1981 increased at a rate of 3.2% per year. This is the highest annual rate of growth in corn yields of the selected corn producing areas and substantially contributes to this area's strong competitive position in corn production. In Nebraska area 400, the five year average corn yield between 1974 and 1981 increased at about .7%/year. This rate of growth in yield resulted in a decrease in relative yield in Nebraska area 400 compared to Iowa area 201.

It is helpful to compare the yield data with production data on 1983 rates of seed and fertilizer application. See Table 28. In Illinois area 300, producers used less seed, more nitrogen, phosphate and potash than in Iowa area 201. The five-year average yield in

Table 27. A Summary of Five Year Average Corn Yields in the Selected Areas.

State & Area	1981[a] Bu/ plant acre	1981[a] %	1981- 1974 % /yr	1978[b] Bu/ plant acre	1978[b] %	1981- 1978 % /yr	1974[c] Bu/ plant acre	1974[c] %	1978- 1974 % /yr
IL 300	118.4	94	.7	113.6	102	1.4	113.1	110	.1
IN 101	108.3	86	1.2	107.0	96	.4	100.2	98	1.7
IO 201	125.6	100	3.2	111.0	100	4.4	102.5	100	2.1
NE 400*	122.5	98	.7	119.9	108	.7	116.6	114	.7

[a] Five year average from 1979 to 1983.
[b] Five year average from 1976 to 1980.
[c] Five year average from 1972 to 1976.

* Irrigated

Illinois area 300 for 1981 was about 6% less than in Iowa area 201. In Indiana area 101, producers used about the same amount of seed, nitrogen, phosphate and potash while producing about 14% less corn per acre compared to Iowa area 201. In Iowa area 200 producers use on average about 15 lbs. of seed, 160 lbs. of nitrogen, 75 lbs. of phosphate, 102 lbs. of potash to produce about 126 bushels of corn per acre. In Nebraska area 400, irrigated corn producers used more seed and nitrogen and less phosphate and potash to produce 2% fewer bushels of corn per acre. These relative seed, fertilizer and yield rates are suggestive of the quality of initial resource endowments including soil, rainfall, temperature etc. relative to corn production in the selected areas. Iowa area 201 appears to have comparative advantage in terms of these initial resource endowments in the production of corn.

FIGURE 4. FIVE-YEAR AVERAGE TREND IN CORN YIELDS IN THE SELECTED AREAS OF ILLINOIS, INDIANA, IOWA AND NEBRASKA

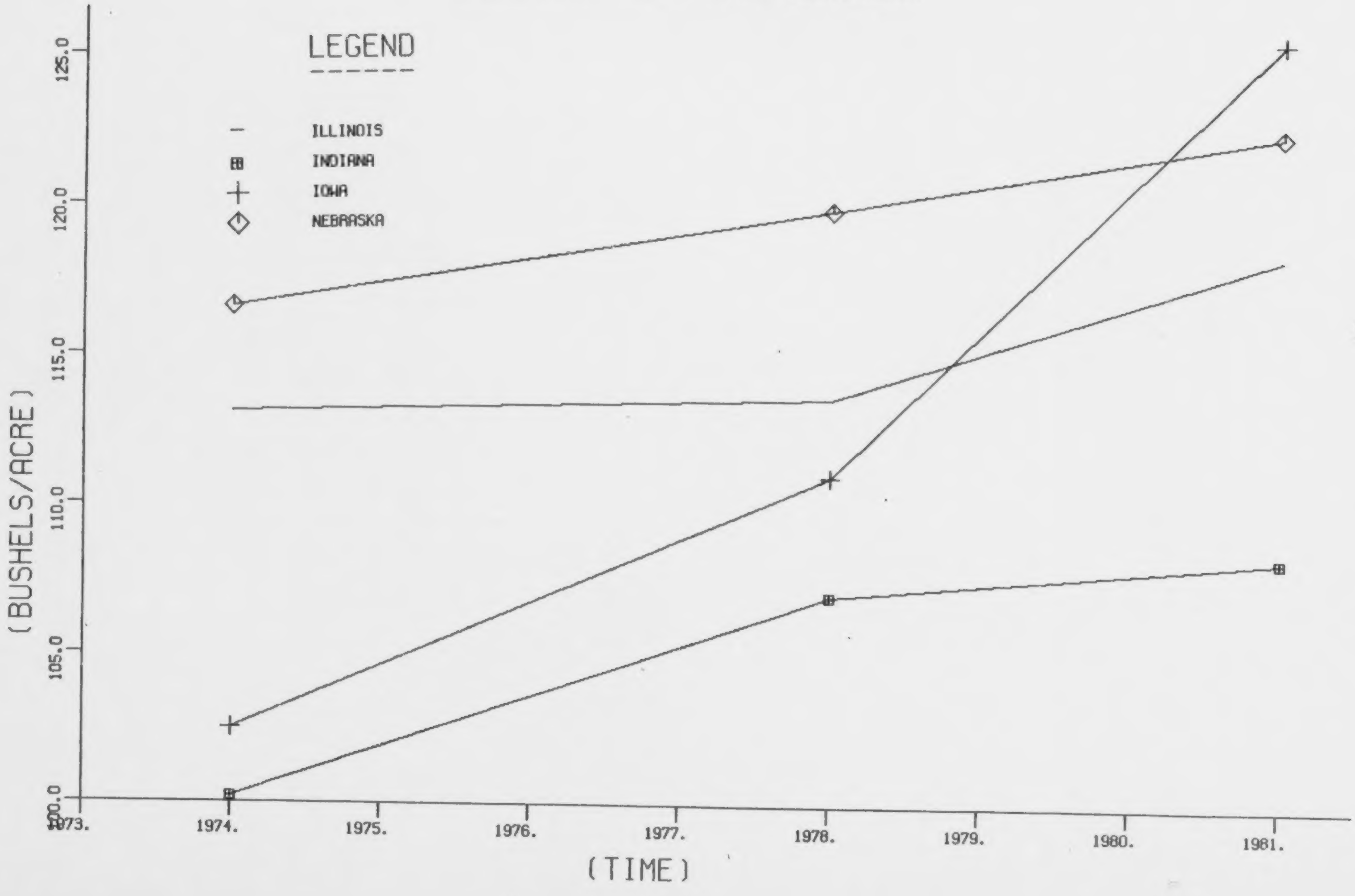


Table 28. Application Rates of Seed, Fertilizer and Lime in the Selected Corn Producing Areas in 1983.

	IL 300		IN 101		IO 201		NE 400*	
Item	lbs/acre	%	lbs/acre	%	lbs/acre	%	lbs/acre	%
Seed	14.7	96	15.2	99	15.3	100	15.6	102
Nitrogen	169	105	163	102	160	100	178	111
Phosphate	106	143	74	99	75	100	25	33
Potash	122	119	100	97	102	100	13	12
Lime	196	-	189	-	0	-	0	-

* Irrigated

Production costs per bushel can be disaggregated by associated cost categories. A summary of preharvest, harvest, ownership and land costs by production area is presented in Table 29. In preharvest costs, the lowest cost is in Iowa area 201 and the highest cost is in Nebraska area 400. In variable harvest costs, the highest cost is in Nebraska area 400 and the lowest cost is in the other three areas. In ownership costs, the lowest cost is in Iowa area 201 and the highest cost is in Nebraska area 400. In land charge, the lowest cost is in Nebraska area 400 and the highest cost is in Illinois area 300.

The land charge is the most costly single input in the production of corn in all the selected producing areas accounting for about 45% of the cost per bushel on average assuming a 10% return on 1982 land prices. Table 30 and Figure 5 summarize the average county level nominal land values in the selected production areas at four-year intervals associated with the COA survey years of 1974, 1978 and 1982. In Illinois area 300, nominal land values appreciated at about

FIGURE 5. QUADRENNIAL TREND IN LAND PRICES IN THE CORN PRODUCING AREAS OF ILLINOIS, INDIANA, IOWA AND NEBRASKA

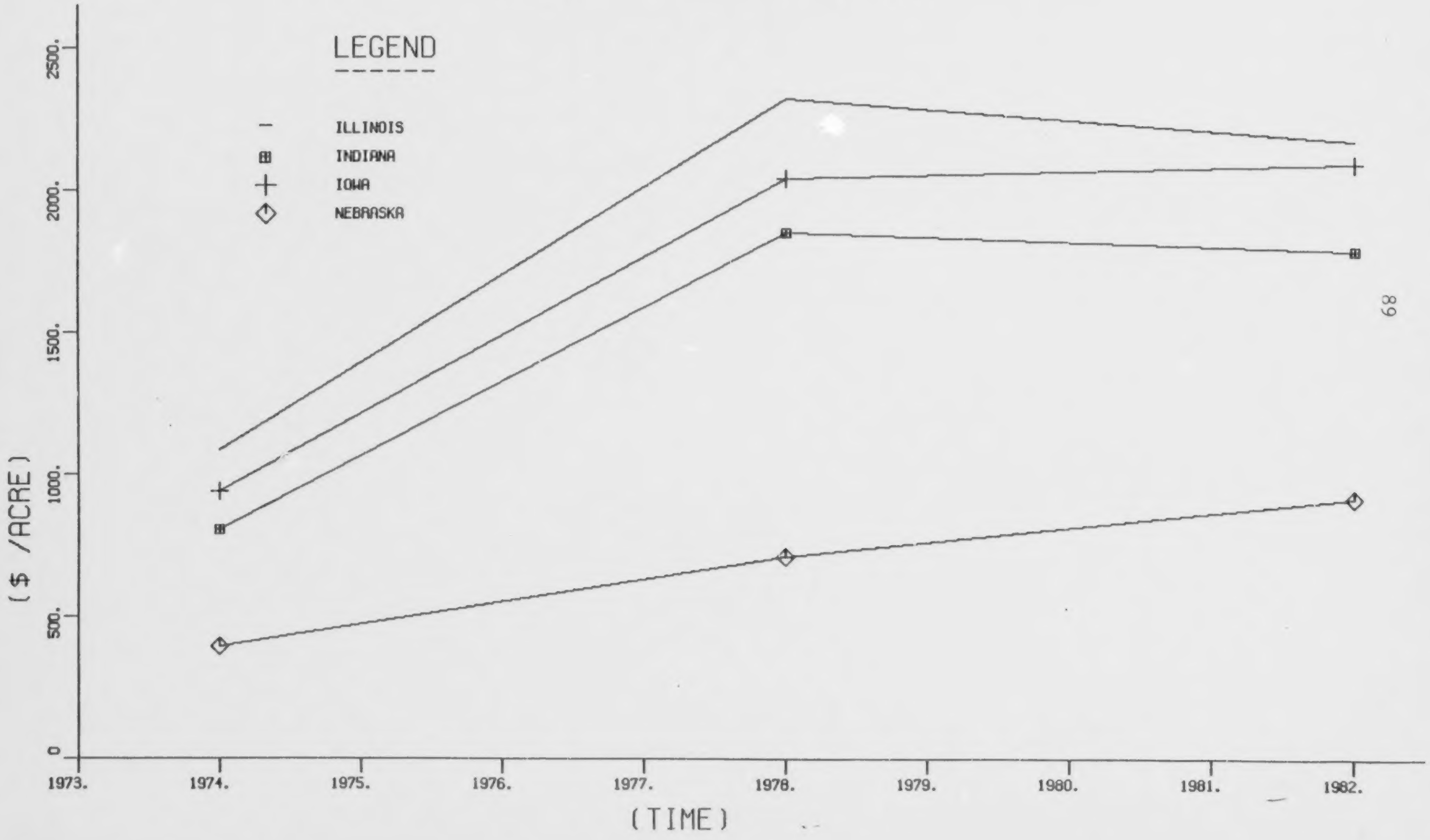


Table 29. Production Costs Per Bushel in the Selected Corn Producing Areas in 1983.

State & Area	Total[1/]		Preharvest		Harvest		Ownership		Land charge[1/]	
	$/Bu	%	$/Bu	%	$/Bu	%	$/Bu	%	$/Bu	%
IL 300	3.75	115	1.30	124	.25	100	.35	117	1.85	112
IN 101	3.60	111	1.30	124	.25	100	.40	133	1.65	100
IO 201	3.25	100	1.05	100	.25	100	.30	100	1.65	100
NE 400*	3.50	108	1.65	159	.30	120	.80	267	.75	45

1/ Includes 10% rate of return on 1982 land values.

* Irrigation

Table 30. Land Values per Acre in the Selected Corn Producing Areas in 1974, 1978 and 1982.

State & Area	1982		1982-74	1978		1982-78	1974		1978-74
	$/acre	%	% /yr	$/acre	%	% /yr	$/acre	%	% /yr
IL 300	2168	104	12.5	2321	114	-1.6	1083	115	28.6
IN 101	1786	85	15.3	1851	91	- .9	804	85	32.6
IO 201	2092	100	15.3	2039	100	.6	942	100	29.1
NE 400*	915	44	16.4	710	35	7.2	396	42	19.8

* Irrigated.

12.5% per year between 1974 and 1982. Even this rate of growth in land values resulted in a decrease in relative land value in Illinois area 300 compared to Iowa area 201. In Indiana area 101, land values appreciated at about 15.3% per year during this same time period. This is the same rate of appreciation of land value as in Iowa area

201. As a result relative land prices between Indiana area 101 and Iowa area 201 remained constant between 1974 and 1982.

In Iowa area 201 nominal land prices appreciated at a rate of 15.3% per year between 1974 and 1982. Almost all of this growth took place between 1974 and 1978 when the rate of appreciation of land in this area was about 29% per year. Between 1982 and 1978 the rate of appreciation for land in this area was only about .6% per year. In Nebraska area 400, land values appreciated at about 16.4% per year between 1974 and 1982. Unlike the other selected areas, land in this area appreciated substantially between 1978 and 1982 at about 7% per year. This high rate of growth in land values in Nebraska area 410 resulted in an increase in relative land value compared to Iowa area 201 of from 42% in 1974 to 44% in 1982.

The combination of the trends in yield and land prices provide useful information regarding trends in comparative advantage assuming other things remain constant. In Illinois area 300, relative yield decreased and relative land prices decreased compared to Iowa area 201 between 1974 and 1982. This combination of relative yield and land trends, if continued into the future, will decrease the competitive position of Illinois area 300 in corn production. In Indiana area 101, relative yield decreased and relative land prices remained unchanged compared to Iowa area 201. This combination of relative yield and land trends, if continued into the future, will also decrease the competitive position of Indiana area 101 in corn production. In Iowa area 201 there has been a substantial increase in corn yields at a rate of about 3% per year as well as substantial increase in nominal land values at a rate of about 15% per year. In Nebraska area 400, relative yield decreased and relative land prices increased compared to Iowa area 201. This combination of relative yield and land price trends, if continued into the future, will reinforce each other and result in a substantial decrease in the competitive position of Nebraska area 400 in corn production. Even declining land prices can maintain these trends as long as similar proportions are maintained. It is unlikely these trends will be offset by lower costs in some other category of inputs.

Preharvest costs represent the second most costly category in corn production in the selected areas. The preharvest cost items include seed, nitrogen, phosphate, potash, herbicides and insecticides, fuel, lubrication, repairs and labor, "other" and general farm overhead. The cost per bushel for each of these items in the selected areas is presented in Table 31. In Illinois area 300, higher preharvest cost items include phosphate, potash, herbicides and insecticides and general farm overhead compared to Iowa area 201. The greater expenditure on phosphate and potash is associated with the additional 43% and 19% use of these fertilizers in Illinois area 300 compared to Iowa area 201. In Indiana area 101, higher preharvest cost items include nitrogen, insecticides, "other" and general farm overhead. The additional expenditure on nitrogen is because it is about 2 cents/lb. more expensive in Indiana area 101 than in Iowa area 201. In Iowa area 201, the major preharvest cost items include seed, nitrogen, phosphate and fuel, lubrication, repairs and labor. In Nebraska area 400, lower preharvest cost items include phosphate and potash while higher preharvest items include herbicides and insecticides, "other" and general farm overhead. The lower phosphate and

Table 31. Preharvest Costs Per Bushel in Determining Comparative Advantage in the Selected Corn Producing Areas in 1983.

Preharvest Item	IL 300		IN 101		IO 201		NE 400*	
	$/Bu	Diff.	$/Bu	Diff.	$/Bu	Diff.	$/Bu	Diff.
Seed	.15	0	.15	0	.15	0	.15	0
Nitrogen	.25	0	.30	.05	.25	0	.25	0
Phosphate	.25	.10	.15	0	.15	0	.05	-.10
Potash	.15	.05	.10	0	.10	0	0	-.10
Herb/Insecticide	.15	.05	.20	.10	.10	0	.20	.10
Fuel, Lub., Repairs & Labor	.15	0	.15	0	.15	0	.15	0
Other	.05	0	.10	.05	.05	0	.70	.65
General Farm Overhead	.15	.05	.15	.05	.10	0	.15	.05
Total	1.30	.25	1.30	.25	1.05	0	1.65	.60

* Irrigated.

potash expenditures are associated with lower rates of application respectively of these fertilizers in Nebraska area 400 compared to Iowa area 201. The substantially higher "other" preharvest cost is associated with fuel, lubrication, repairs and labor associated with irrigation.

Capital ownership cost is the third largest cost category in the production of corn in the selected areas. Capital ownership costs include depreciation, insurance, taxes, and interest (opportunity cost) on machinery and tractors associated with particular field operations. These operations include land preparation, cultivation, fertilizer and chemical application, planting, irrigation, harvesting and hauling. See Table 32. Harvesting ownership costs are higher in all of the selected corn producing areas relative to Iowa area 201. Recall from Table 23 that total producer harvesting costs per acre are nearly identical in Illinois area 300 and Indiana area 101 and only slightly higher in Nebraska area 400. In Iowa area 201, however, harvesting size economies exist because a substantial portion of the crop is custom harvested at a substantially lower rate per acre. Further, about 13% of the corn crop grown on very large enterprises in Iowa area 201 is harvested with a corn picker which lowers the total producer harvesting cost as well. The result is a competitive advantage in harvesting ownership costs in Iowa area 201. The additional irrigation ownership cost in Nebraska area 400 is simply part of the additional expense associated with growing corn in an area without sufficient rainfall. The difference in ownership cost for hauling is associated with the extent to which grain wagons and/or 2 ton trucks are used to haul grain out of the field. Trucks are substantially more costly to use in hauling relative to grain wagons.

3.3 Summary

In Illinois area 300, the relative lack of comparative advantage is due to higher expenditure on phosphate, potash, herbicide and insecticide while having a 6% lower yield as well as higher harvesting ownership costs compared to Iowa area 201. The trends in relative yields and land prices (whether increasing or decreasing in the case of land) indicate that the competitive position in corn production in this area will decrease. Size economies exist for very large enterprises in this area and can be exploited to reduce comparative

Table 32. Capital Ownership Cost Per Bushel in Determining Comparative Advantage in the Selected Corn Producing Areas in 1983.

Field Operation	IL 300		IN 101		IO 201		NE 400	
	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff
Land Preparation	.05	0	.05	0	.05	0	.05	0
Cultivation	0	0	0	0	0	0	0	0
Fertilizer and Chemical Appl.	0	0	0	0	0	0	0	0
Planting	0	0	0	0	0	0	0	0
Irrigation	0	0	0	0	0	0	.35	.35
Harvesting	.25	.10	.25	.10	.15	0	.25	.10
Hauling	.05	-.05	.10	0	.10	0	.15	.05
Total	.35	.05	.40	.10	.30	0	.80	.50

disadvantage. The Herfindahl indices imply that producers are beginning to increase enterprise size.

In Indiana area 101, the lack of comparative advantage is due to the relative price of nitrogen and additional expenditure on pesticides as well as higher harvesting ownership costs compared to Iowa area 201. The trends in relative yield and land prices, if continued, indicate that the competitive position in corn production in this area will decrease. Size economies exist for very large and large enterprises in Indiana area 101 that can be exploited in the future. The static and dynamic Herfindahl indices indicate that producers in this area are, in fact, moving toward larger enterprise size.

In Iowa area 201, comparative advantage is related to yields relative to fertilizer, herbicide and insecticide used, as well as lower harvesting ownership costs associated with custom harvesting and the use of corn pickers. The trends in yield and land prices, if they continue, indicate that the competitive position of this area can be maintained though average cost per bushel will increase. Size economies exist for very large enterprises in this area and can be exploited to improve comparative advantage. The static and dynamic Herfindahl indices imply that the producers in Iowa area 201 are beginning to exploit size economies.

In Nebraska area 400, the lack of comparative advantage is due to the additional expenditure associated with well-pumped irrigation water. The trends in yield and land prices, if they continue, indicate that the competitive position of this area will substantially decrease. Size economies exist for very large enterprises in this area. The static and dynamic Herfindahl indices imply that producers in Nebraska area 400 have moved toward larger enterprise sizes in an effort to exploit size economies and are continuing to do so.

CHAPTER IV

SOYBEANS

This section presents the particulars associated with size economies within and comparative advantage among the selected soybean producing areas. The selected soybean producing areas are:

(1) Illinois Area 300

(2) Iowa Area 201

(3) Mississippi Area 100

(4) Ohio Area 101

For these soybean-producing areas, an analysis of size economies and comparative advantage is presented in terms of cost-of-production data and other estimated indices.

4.1 Size Economies in Soybean Production

The four measures or indications of size economies are estimated according to the procedures outlined in the methodology section. These indicators include production costs, utilization of harvesting equipment as well as static and dynamic Herfindahl production concentration indices. A summary of these indices is presented in Table 33 by enterprise size for each of the selected production areas. Table 34 presents the results of the scoring procedure.

In Illinois area 300, very large soybean enterprises have about a 5% cost disadvantage relative to large enterprises. Very large and

Table 33. The Indices Used to Determine Size Economies in the Selected Soybean Producing Areas in 1983.

State, Area, and Enterprise Size	Cost/Bu.	Enterprise Size Acres		Harvest Machinery Full Utilization		Herfindahl Indices	
	%	Mean	S.D.	Max.	Min.	Static[1] %	Dynamic[2] %
IL 300							
VL	100	684	137	2.4	1.4	100	65
L	95	418	47	1.3	.9	142	16
M	102	271	37	.9	.6	80	-4
IO 201							
VL	100	707	229	2.7	1.3	100	38
L	104	341	72	1.2	.7	202	19
M	108	210	35	.7	.4	198	-5
MS 100							
VL	100	1262	385	2.1	1.2	100	9
L	116	894	49	1.2	1.1	24	11
M	99	795	42	1.1	1.0	24	11
OH 101							
VL	100	897	48	2.5	2.2	100	71
L	84	493	97	1.6	1.0	115	21
M	86	244	76	.9	.3	73	-3

[1] 1982 absolute Herfindahl measures are normalized using the very large size as the base.

[2] 1978 and 1982 Herfindahl indices are used to measure the change in concentration. The change can result from movement within and between size categories.

large soybean enterprises can fully utilize 1 or more self-propelled six-row harvesters. This size harvester is assumed to have an annual harvesting capacity of about 380 acres and a 10 year useful life. The static Herfindahl measure of relative production concentration in 1982 is greatest for the large enterprises. The dynamic Herfindahl measure of the change in relative production concentration between 1978 and 1982 is positive only for the very large and large enterprises. Productive resources in Illinois area 300 appear to be concentrated in

Table 34. Scoring Table Used to Determine Size Economies in the Selected Soybean Producing Areas in 1983.

State, Area & Enterprise Size	Production Cost	Harvester Utilization	Herfindahl Indices		Total
			Static	Dynamic	
IL 300					
VL	-	+	-	+	2
L	+	+	+	+	4
M	-	-	-	-	0
IO 201					
VL	+	+	-	+	3
L	-	+	+	+	3
M	-	-	+	-	1
MS 100					
VL	+	+	+	-	3
L	-	-	-	-	0
M	+	+	-	-	2
OH 101					
VL	-	-	+	+	3
L	+	+	+	+	4
M	+	-	-	-	1

the large enterprise size. The trend in resource concentration is toward very large and large enterprises at the expense of medium and small (those below the 40th decile in size) enterprise sizes. The scoring results are 2 - 4 - 0 for the very large, large and medium enterprises respectively. Thus, there is evidence to argue that cost economies exist for the large enterprises relative to very large and medium size enterprises in soybean production in Illinois area 300.

In Iowa area 201, very large soybean enterprises have a 4% and 8% cost advantage relative to large and medium enterprises, respectively. Very large and large soybean enterprises can fully utilize 1 or more self-propelled six row harvesters. And, the relative production concentration in 1982 is greatest for large and medium size enterprises. The change in production concentration between 1978 and 1982 is, however, positive only for very large and large enterprises. Thus, productive resources in Iowa area 201 are presently concentrated in the large and medium enterprise size. The trend in resource concentration, however, is toward very large and large enterprises at the expense of medium and small enterprises. The scoring results are 3 - 3 - 1 for very large, large and medium enterprises respectively. Thus, there is evidence to argue that size economies exist for very large and large enterprises relative to medium-size enterprises in soybean production in Iowa area 201.

In Mississippi area 100, very large soybean enterprises have a cost advantage relative to large enterprises. All three soybean enterprises can fully utilize 1 or more self-propelled eight-row harvesters. This size harvester is assumed to have an annual harvesting capacity of about 800 acres. And, even the medium-size enterprise everages 795 acres. The relative production concentration in 1982 is greatest for very large enterprises. The change in production concentration between 1978 and 1982 is positive for each enterprise size. Productive resources appear to be concentrated in the very large enterprise size and relatively stable under the current configuration of enterprise sizes. The scoring results are 3 - 0 - 2 for very large, large and medium enterprises respectively. This evidence suggests that there is no clear cost advantage for any enterprise size of 800 acres or more in Mississippi area 100.

In Ohio area 101, very large soybean enterprises have a cost disadvantage relative to large and medium enterprises. Very large and large soybean enterprises can fully utilize 1 or more self-propelled six-row harvesters. Production concentration in 1982 is greatest for large enterprises. The change in relative production concentration between 1978 and 1982 is positive for very large and large enterprises. Productive resources in Ohio area 101 appear to be concentrating in very large and large enterprise sizes at the expense of medium-size and smaller enterprises. The scoring results are 3 - 4 - 1 for very large, large and medium enterprises respectively. Thus, existing size economies do appear to be modest ones.

4.1.1 A More Deatiled Analysis of Cost

A more detailed examination of the components of the production cost measures provides a better understanding of the sources of size economies. Total cost per unit of output is equal to the total cost per acre divided by the yield per acre. Table 35 summarizes the production costs and yields by enterprise size for the selected soybean producing areas. Total cost per bushel is generally constant across enterprise size in the selected soybean producing areas. Yields in general are nearly constant across enterprise sizes. Medium size enterprises in general tend to have slightly lower total cost per acre.

Total cost per acre can be disaggregated into preharvest, harvest and capital ownership costs. See Table 36. Capital ownership costs are defined as depreciation, taxes, insurance and interest (opportunity cost) on machinery and tractors used in the production process. Except in Illinois area 300, very large enterprises in the selected areas have greater per acre capital ownership costs than large and medium enterprises. Variable harvest costs are nearly uniform across enterprise sizes in the selected soybean producing areas except in Mississippi area 100. In this area medium enterprises

Table 35. Production Costs and Yield by Enterprise Size in the Selected Soybean Producing Areas in 1983.

State, Area & Enterprise Size	Total Cost[1]		Yield[2]		Total Cost[1]	
	$/Bu.	%	Bu./Acre	%	$/Acre	%
IL 300						
VL	3.56	100	38.2	100	136	100
L	3.38	95	38.2	100	129	95
M	3.64	102	37.4	98	136	100
IO 201						
VL	3.32	100	36.8	100	122	100
L	3.44	104	36.6	99	126	103
M	3.58	108	36.3	99	130	107
MS 100[3]						
VL	5.20	100	25.0	100	130	100
L	6.02	116	23.6	94	142	109
M	5.17	99	23.6	94	122	94
OH 101						
VL	4.27	100	35.6	100	152	100
L	3.59	84	34.8	98	125	82
M	3.66	86	34.4	97	126	83

1. Excluding land charge.
2. 1982 state level yields per harvested acre for irrigated and non-irrigated.
3. 1982 production year data.

custom harvest about 25% of their harvested acres. Finally, preharvest variable costs differ substantially across enterprise size in the selected soybean producing areas with no obvious size related pattern.

Preharvest costs can be disaggregated into associated cost components to get yet a clearer picture of relative costs between enterprises within the selected soybean producing areas. See Table 37. In Illinois area 300, very large enterprises have substantially higher fertilizer, herbicide and insecticide expenditures. Medium enterprises, however, have higher fuel, lubrication, repairs, labor and "other" expenditures relative to very large enterprises in this area

Table 36. Preharvest, Harvest and Capital Ownership Costs by Enterprise Size in the Selected Soybean Producing Areas in 1983.

State, Area & Enterprise Size	Total Cost[1]		Preharvest		Harvest		Ownership	
	$/Acre	%	$/Acre	%	$/Acre	%	$/Acre	%
IL 300								
VL	136	100	73	100	12	100	51	100
L	129	95	65	89	12	100	52	102
M	136	100	71	97	11	92	54	106
IO 201								
VL	122	100	61	100	10	100	51	100
L	126	103	71	116	11	110	44	86
M	130	107	73	120	11	110	46	90
MS 100[2]								
VL	130	100	63	100	9	100	58	100
L	142	109	75	119	10	111	57	98
M	122	94	66	105	14	156	42	72
OH 101								
VL	152	100	91	100	10	100	51	100
L	125	82	70	77	9	90	46	90
M	126	83	70	77	10	100	46	90

1. Excluding land charge.

2. 1982 production data.

which tends to offset the gain from lower fertilizer costs. In Iowa area 201, very large enterprises have substantially lower fuel, repair, labor and "other" expenditures. These "other" costs include the pecuniary internal economies associated with custom tillage, planting and cultivation. In Mississippi area 100, very large enterprises have substantially lower herbicide and insecticide costs while having higher and substantially higher fuel, repair and labor costs relative to large and medium enterprises. In Ohio area 101, very large enterprises have substantially higher fertilizer, insecticide and herbicide costs relative to large and medium enterprises.

Table 37. Preharvest Variable Costs Per Acre in Determining Size Economies in the Selected Soybean Producing Areas in 1983.

		Illinois 300		Iowa 201		Mississippi 100		Ohio 101	
		$/acre	Diff[1]	$/acre	Diff[1]	$/acre	Diff[1]	$/acre	Diff[1]
Seed	VL	8	0	11	0	8	0	11	0
	L	8	0	11	0	8	0	11	0
	M	8	0	10	-1	8	0	11	0
Fertilizer	VL	10	0	4	0	0	0	21	0
	L	0	-10	5	1	0	0	11	-10
	M	3	-7	4	0	0	0	10	-11
Pesticides	VL	23	0	17	0	10	0	29	0
	L	21	-2	17	0	24	14	21	-8
	M	21	-2	17	0	21	11	20	-9
Fuel, Repairs & Labor	VL	19	0	16	0	35	0	18	0
	L	20	1	20	4	31	-4	16	-2
	M	24	5	20	4	25	-10	18	0
Other	VL	3	0	4	0	3	0	3	0
	L	6	3	9	5	5	2	2	-1
	M	5	2	13	9	5	2	2	-1
General Farm Overhead	VL	10	0	9	0	7	0	9	0
	L	10	0	9	0	7	0	9	0
	M	10	0	9	0	7	0	9	0
Total	VL	73	0	61	0	63	0	91	0
	L	65	-8	71	10	75	12	70	-21
	M	71	-2	73	12	66	3	70	-21

[1] Difference in cost for very large enterprise relative to either large or medium size enterprise costs.

Differences in fuel, repair and labor costs across enterprise sizes are related to the size and number of machines and tractors and the times over the field for preharvest field operations.

Capital ownership costs can also be disaggregated into associated cost components. See Table 38. Capital ownership cost is the cost of durables used in land preparation, cultivation, fertilizer and chemical application, planting, harvesting and hauling. In Illinois area 300, capital ownership costs for all the field operations are nearly equal across enterprise size. The higher hauling ownership cost by medium enterprises in this area relates to the additional use of the pick-up truck relative to the other enterprises. In Iowa area 201, very large enterprises have higher ownership costs associated with land preparation, fertilizer and chemical application, planting and harvesting. Large and medium soybean enterprises have lower capital ownership expenditures on these field operations because some custom tillage, planting, cultivation and harvesting are used by these enterprises (See Table 39). In Mississippi area 100, very large and large enterprises have higher ownership costs in land preparation, cultivation, harvesting and hauling, than do the medium size enterprises. In land preparation, very large and large enterprises use, on average, an additional 45 horsepower relative to medium enterprise. Very large enterprises use more mechanical cultivation while large and medium enterprise use more herbicides to control weeds in this area. Finally, medium soybean enterprise custom harvest and haul about 25% of the harvested crop while very large enterprises reported no custom harvesting or haul of soybeans. In Ohio area 101, very large enterprises have higher land preparation ownership costs. In land

Table 38. Ownership Costs Per Acre in Determining Size Economies in the Selected Soybean Producing Areas in 1983.

Field Operation		Illinois 300		Iowa 201		Mississippi 100		Ohio 101	
		$/acre	Diff[1]	$/acre	Diff[1]	$/acre	Diff[1]	$/acre	Diff[1]
Land Preparation	VL	11	0	12	0	16	0	13	0
	L	12	1	10	-2	17	1	9	-4
	M	12	1	11	-1	9	-7	10	-3
Cultivation	VL	4	0	3	0	13	0	2	0
	L	5	1	4	1	8	-5	1	-1
	M	4	0	4	1	7	-6	2	0
Fertilizer & Chemical Application	VL	2	0	4	0	1	0	3	0
	L	1	-1	2	-2	2	1	4	1
	M	2	0	1	-3	2	1	2	-1
Planting	VL	5	0	5	0	3	0	6	0
	L	5	0	4	-1	3	0	5	-1
	M	5	0	4	-1	4	1	5	-1
Harvesting	VL	23	0	24	0	18	0	23	0
	L	23	0	21	-3	20	2	23	0
	M	23	0	22	-2	15	-3	23	0
Hauling	VL	6	0	3	0	7	0	4	0
	L	6	0	3	0	7	0	4	0
	M	8	2	4	1	5	-2	4	0
Total	VL	51	0	51	0	58	0	51	0
	L	52	1	44	-7	57	-1	46	-5
	M	54	3	46	-5	42	-16	46	-5

[1] Difference in cost for very large enterprises relative to either large or medium size enterprise costs.

Table 39. Harvesting Costs Per Acre in the Selected Soybean Producing Areas in 1983.

State, Area & Enterprise Size	Custom Harvest		Producer Harvest[1]		Total Harvest Cost	
	%	$/acre	%	$/acre	%	$/acre
IL 300						
VL	0	0	100	27.87	100	27.87
L	0	0	100	27.87	100	27.87
M	0	0	100	27.87	100	27.87
IO 201						
VL	0	0	100	27.78	100	27.78
L	14	24.43	86	27.68	100	27.23
M	10	23.60	90	27.66	100	27.25
MS 100						
VL	0	0	92	26.74	92	26.74
L	0	0	97	26.73	97	26.73
M	25	25.00	75	26.73	100	26.30
OH 101						
VL	0	0	100	27.90	100	27.90
L	0	0	100	27.90	100	27.90
M	0	0	100	27.90	100	27.90

1. Includes fuel, lubrication, repairs, labor and capital ownership costs.

preparation, very large enterprises in this area use on average an additional 30-40 horsepower relative to large and medium enterprises.

Harvesting ownership costs are the largest single component of total ownership costs. Harvesting ownership costs are constant across enterprise size adjusted for the percent of custom harvesting. Further, the same size harvester is used across enterprise sizes. A six-row self-propelled harvester is used in Illinois area 300, Iowa area 201 and Ohio area 101. An eight-row self-propelled harvester is used in Mississippi area 100. The extent of utilization of these harvesters by enterprise size is determined and used as one of the four indices of size economies. Custom harvesting rates are $2-3/acre lower than total owner-operator harvesting costs and is a slight source of pecuniary size diseconomies in Iowa area 201 and Mississippi area 100.

In summary we generally find the absence of size economies in soybean production in the selected areas is due to the following factors. Yield is only a slight source of size economies in soybean production. In Illinois area 300, size diseconomies for very large enterprises are associated with the substantially higher fertilizer, herbicide and insecticide expenditures without corresponding higher yield. In Iowa area 201, the size economies for very large and large enterprises are associated with lower costs of owner provided relative to custom provided durable services other than harvesting. In Mississippi area 100, the absence of size economies is related to the diseconomies of additional horse power used by very large and large enterprises. In Ohio area 101, size diseconomies for very large enterprises is related to the substantially higher expenditure on fertilizer, herbicide and insecticide without corresponding higher yields.

4.2 Comparative Advantage in Soybean Production

In the previous section we focused our attention exclusively on size economies within a production area. In this section we shift our focus to the comparative advantage in soybean production among areas. As described in the methodology section, production data by enterprise size are combined using the static relative Herfindahl index as a weight. To this information is added county-level land prices from the 1982 Census of Agriculture (COA). Yield information on the other hand, is changed from 1982 COA data to the Statistical Reporting Service (SRS) data on county level yield per planted acre using a five-year average. The overall objective for including comparative advantage is to provide a context within which to analyze size economies. The secondary objective is to determine the source or explain the absence of comparative advantage between the selected production areas.

We begin by comparing the relationship between comparative advantage and size economies in the selected soybean producing areas. See Table 40. The static Herfindahl index is the absolute measure of production concentration for the entire state. This static absolute index is equal to the sum ofthe static relative Herfindahl indices for the three enterprise size categories analyzed above within the respective states in 1982. The dynamic Herfindahl index is a measure of the change in the static absolute measure from 1978 to 1982 for a particular state. In Illinois area 300, total cost per bushel of

Table 40. Relationship Between Comparative Advantage and Size Economies in the Selected Soybean Producing Areas in 1983.

State & Area	Total Cost[1]		Size Econ	Relative Size Acres	Herfindahl	
	$/Bu	%			Static[2/3] Absolute	Dynamic[4] %
IL 300	9.07	103	L	464	2,700-8	17
IO 201	8.82	100	VL & L	362	2,200-8	10
MS 100	10.91	124	none	1126	27,330-8	9
OH 101	9.29	105	none	570	5,670-8	21

[1] Including land charge & 5-year average yield 1983-1979.

[2] State level measure for three enterprise size categories.

[3] Scientific notation (-8) refers to moving the decimal point eight places to the left e.g. 2,700-8 equals .00002700.

[4] Change in state level measure between 1982-1978.

soybeans is about 3% higher than in Iowa area 300. Size economies exist for large enterprises only. The average enterprise size is approximately 460 acres in this area. Enterprises can utilize between .6 and 2.4 units of self-propelled six-row harvester capacity. The static absolute Herfindahl index or the measure of production concentration is low relative to the Mississippi and Ohio areas. This implies that soybean production is not concentrated in one or more enterprise size. The dynamic Herfindahl index or the change in production concentration between 1978 and 1982 is 17% or about 4.3% per year. This change in concentration implies that producers are moving toward one or more enterprise size categories in an effort to achieve size economies such as they exist and thereby reduce costs.

In Iowa area 201, total cost per bushel of soybeans is the lowest of the selected soybean producing areas. In this area, size economies exist for very large and large enterprises. The average enterprise size is about 360 acres in this area. Enterprises can utilize between .4 and 2.7 units of self-propelled six-row harvester capacity. The measure of production concentration is the lowest of the selected areas. This implies that soybean production is not concentrated in one or more enterprise sizes. The change in production concentration between 1978 and 1982 is 10% or 2.5% per year. This small change in production concentration implies that Iowa producers are slowly responding to size economies which exist in soybean production.

In Mississippi area 100, total cost per bushel of soybeans is about 24% higher than in Iowa area 300. In Mississippi area 100, no one enterprise size has a clear advantage relative to the other enterprise sizes. The average enterprise size in this area is about

1100 acres. Enterprise can utilize between 1 and 2 self-propelled eight-row harvesters. The measure of production concentration in 1982 is the highest of the selected soybean producing areas. This implies that production is concentrated in one or more enterprise size. The change in soybean production concentration between 1978 and 1982 is about 9% or 2.3% per year. This is the lowest change in concentration of the selected areas and implies that producers have probably rather fully exploited size economies, given the current enterprise configuration and technology, which exist in soybean production in Mississippi area 100.

In Ohio area 101, total cost per bushel of soybeans is higher than in Iowa area 300. In Ohio area 101, size economies do not exist for very large enterprises relative to large and medium-size enterprises. The average enterprise size is approximately 570 acres. Enterprises can utilize between .3 and 2.5 units of self-propelled six-row harvester capacity. The measure of production concentration is high relative to Iowa area 201 and Illinois area 300. The static relative Herfindahl index indicates that production is concentrated in the large enterprise size category. The change in soybean production concentration between 1978 and 1982 is the highest of the selected areas at about 21% or 5.3% per year. This implies that producers are moving toward the large enterprise size relative to the medium enterprise size presumably in an effort to increase their total revenue.

Let us turn our attention now to the objective of determining the source or explaining the absence of comparative advantage between the selected soybean producing areas. The comparative advantage for a production area is based on the total production cost per unit of output of a representative enterprise associated with the 40th through 90th deciles of enterprise sizes. The production costs and yield for these representative enterprises for the selected soybean producing areas is presented in Table 41. On the basis of total cost per bushel Iowa area 201 at $8.82/bu has the lowest while Illinois area 300 and Ohio area 101 have 3% and 5% higher costs respectively. Mississippi area 100 is a marginal soybean producing area with about 24% higher cost compared to Iowa area 201. On the basis of soybean yields, Illinois has the highest at about 38.6 bushels per acre based on a five-year average from 1979 to 1983, while the Mississippi area 100 has the lowest at about 22 bushels per acre. On the basis of total production costs per acre Mississippi area 100 has the lowest at about $240 per acre while Illinois area 300 has the highest at about $350 per acre.

Table 41. Comparative Advantage in Soybean Production in the Selected Areas in 1983.

State & Area	Total Cost 1/		Yield 2/		Total Cost 1/	
	$/Bu	%	Bu/Acre	%	$/Acre	%
IL 300	9.07	103	38.6	101	350	104
IO 201	8.82	100	38.1	100	336	100
MS 100	10.91	124	22.0	58	240	71
OH 101	9.29	105	33.8	89	314	93

1/ Including land charge.

2/ Average yield from 1983-1979.

The SRS data on yield per planted acre from 1972 to 1983 for the counties in these selected soybean producing area reveal that relative yields have remained essentially unchanged. See Table 42 and Figure 6. In Illinois area 300, between 1974 and 1981, the five-year average soybean yields increased about 1.8% per year. This average rate of growth in yield resulted in a very small decrease in relative yield in Illinois area 300 compared to Iowa area 201. In Iowa area 201, the five-year average soybean yields between 1974 and 1981 increased at a rate of 2% per year or about average for the selected producing areas in the North Central Region. In Mississippi area 100, the five-year average soybean yields between 1974 and 1981 increased about 1% per year. This average rate of growth in yield resulted in a decrease in relative yield in Mississippi area 100 compared to Iowa area 201 from 62% in 1974 to 58% in 1981. In Ohio area 101, the five-year average soybean yields between 1974 and 1981 increased about 2% per year. This average rate of growth in yield resulted in a constant relative yield in Ohio area 101 compared to Iowa

Table 42. A Summary of Five Year Average Soybean Yield in the Selected Areas.

State & Area	1981 Bu/ plant Acre	1981 %	1981-1974 % /yr.	1978 Bu/ plant Acre	1978 %	1981-1978 % /yr.	1974 Bu/ plant Acr	1974 %	1978-1974 % /yr.
IL 300	38.6	101	1.8	38.2	105	.3	34.2	102	2.9
IO 201	38.1	100	2.0	36.3	100	1.7	33.5	100	2.1
MS 100	22.0	58	.9	21.3	59	1.1	20.7	62	.7
OH 101	33.8	89	2.0	35.6	98	-1.7	29.7	89	5.0

FIGURE 6. FIVE-YEAR AVERAGE TREND IN SOYBEAN YIELDS IN THE SELECTED AREAS OF ILLINOIS, IOWA, MISSISSIPPI AND OHIO

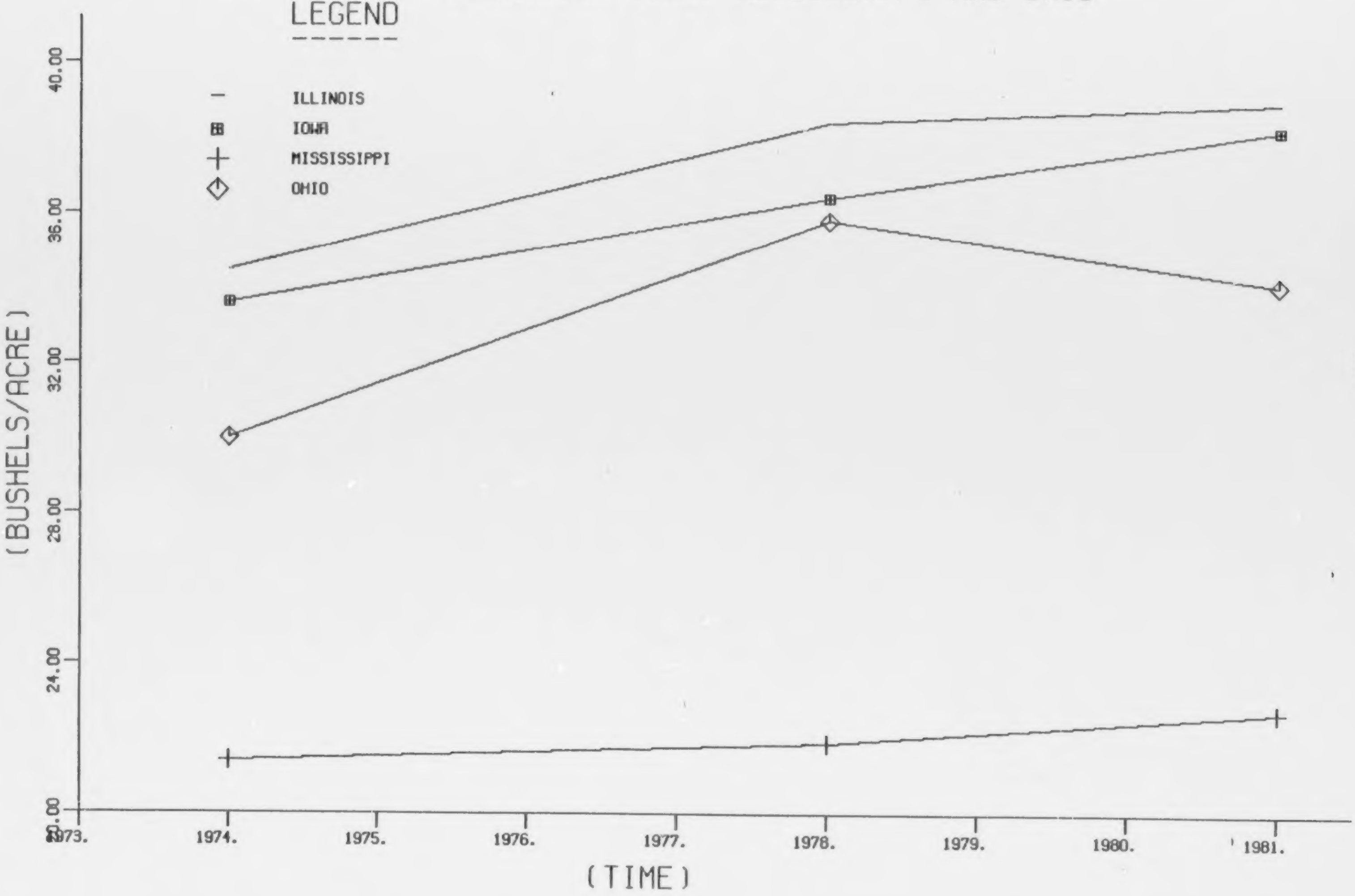


Table 43. Application Rates of Seed and Fertilizer in the Selected Soybean Producing Areas in 1983.

	IL 300		IO 201		MS 100		OH 101	
Input	lbs/acre	%	lbs/acre	%	lbs/acre	%	lbs/acre	%
Seed	56.9	94	60.7	100	59.1	97	71.1	117
Nitrogen	.1	2	4.4	100	0	0	1.8	41
Phosphate	8.0	86	9.3	100	.1	1	18.2	196
Potash	15.7	132	11.9	100	.1	1	72.8	612

area 201 of 89% in 1974 and 1981. In general relative soybean yields have remained quite stable between the selected producing areas.

It is helpful to compare the yield data with production data on rates of seed and fertilizer application. See Table 43. Fertilizer application refers primarily to phosphate and potash since the soybean plant has the capacity to "fix" its own nitrogen. In Illinois area 300, soybean producers use less seed and phosphate and more potash while producing only slightly higher yields than in Iowa area 201. In Iowa 201, soybean producers use about 61 lbs. of seed, 9 lbs. of phosphate, 12 lbs. of potash, as well as 4 lbs. of nitrogen per acre. The five year average yield centering on 1981 was about 38 bushels per acre. In Mississippi area 100, soybean producers use less seed, phosphate and potash and produce substantially lower yields than in Iowa area 201. In Ohio area 101, soybean producers use more seed, phosphate, potash and also produce lower yields than in Iowa area 201. These relative rates of seed, fertilizer and yield are suggestive of the differences in the quality of the initial resource endowments including soil, rainfall, temperature, etc., as well as relative prices in the selected areas. Iowa area 201 appears to have a slight comparative advantage compared to Illinois area 300 in the production of soybeans.

Production costs per bushel can be disaggregated by associated cost categories. Table 44 provides a summary of preharvest, harvest, ownership and land costs by production area. The lowest per bushel preharvest cost is in Illinois area 300 and the highest preharvest cost is in Mississippi area 100. The highest variable harvest cost is in Mississippi area 100. The lowest capital ownership cost is in Iowa area 201 and the highest cost in Mississippi area 100. Finally, the lowest land cost is in Mississippi area 100 and the highest land cost is in Illinois area 300.

The land charge is the most costly single input in the production of soybeans in all the selected producing areas comprising on average about 60% of the cost of inputs assuming a 10% return on 1982 land prices. Figure 7 and Table 45 summarize the average county level nominal land values in the selected production areas at four-year intervals associated with the Census of Agriculture survey years 1974, 1978 and 1982. In Illinois area 300, land values between 1974 and 1982 increased by about 13% per year. In Iowa area 201, land values increased about 15% per year, in Mississippi area 100, land values increased about 20% per year. In Ohio area 101, land values increased about 14% per year. These rates of appreciation in nominal land values resulted in a decrease in the relative land values in Illinois area 300; an increase in relative land values in Mississippi area 100; and a decrease in relative land values in Ohio area 101 compared to Iowa area 201. The appreciation of land between 1974 and 1982 in Mississippi area 100 was substantially greater than in the other

Table 44. Production Costs Per Bushel in the Selected Soybeans Producing Areas in 1983.

State & Area	Total[1]		Preharvest		Harvest		Ownership		Land charge[1]	
	$/Bu	%	$/Bu	%	$/Bu	%	$/Bu	%	$/Bu	%
IL 300	9.05	103	1.80	97	.30	100	1.35	113	5.60	103
IO 201	8.80	100	1.85	100	.30	100	1.20	100	5.45	100
MS 100	10.90	124	2.95	159	.45	150	2.50	208	5.00	92
OH 101	9.30	106	2.30	124	.30	100	1.40	117	5.30	97

1. Includes 10% of land values in 1982.

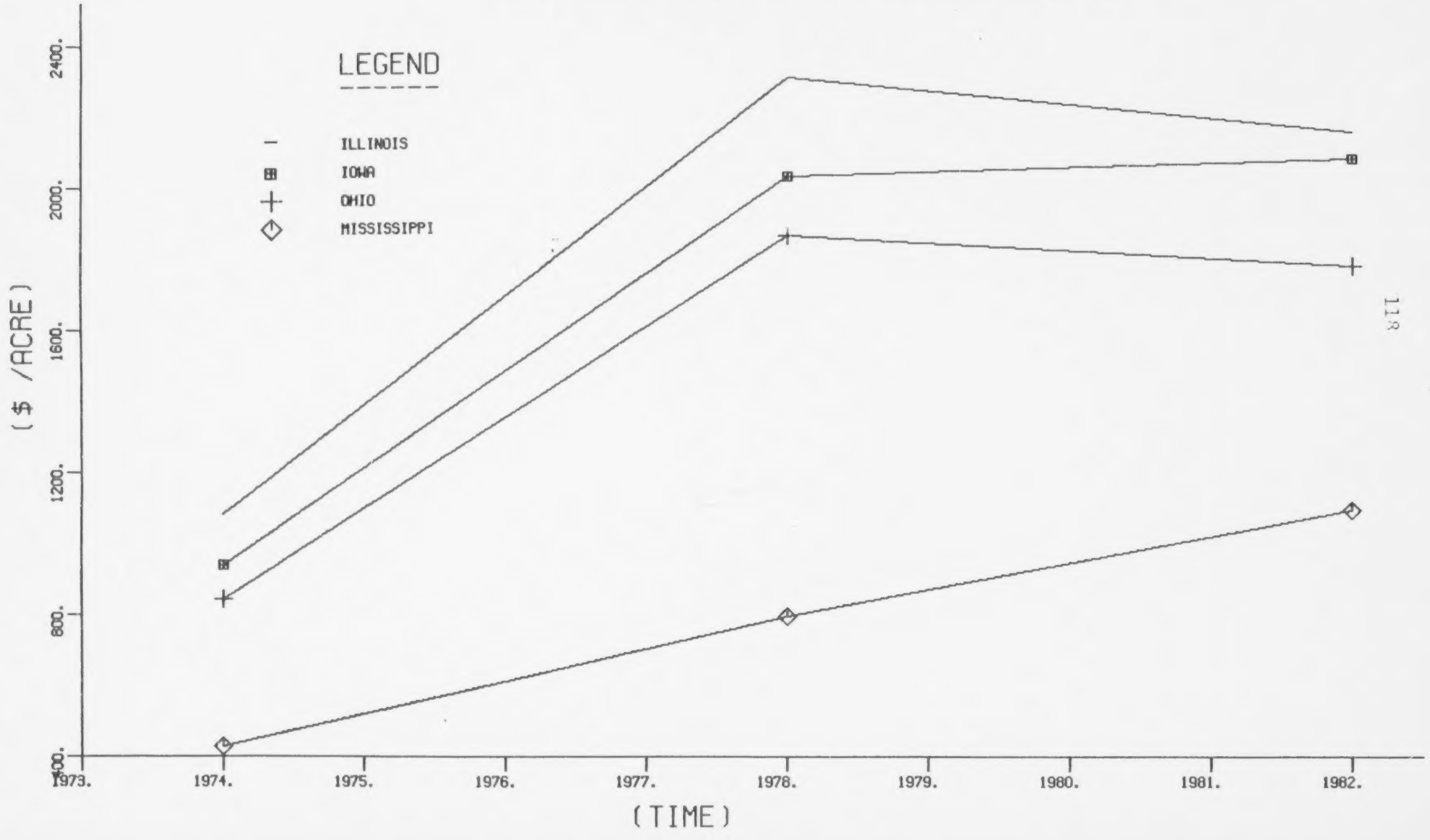
Table 45. Land Values Per Acre in the Selected Soybean Producing Areas in 1974, 1978 and 1982.

State & Area	1982		1982-74 % /yr	1978		1982-78 % /yr	1974		1978-74 % /yr
	$/acre	%		$/acre	%		$/acre	%	
IL 300	2168	104	12.5	2321	114	-1.6	1083	115	28.6
IO 201	2092	100	15.3	2039	100	.6	942	100	29.1
MS 100	1097	52	19.6	797	39	9.4	427	45	21.7
OH 101	1789	86	14.0	1871	92	-1.1	843	89	30.5

selected soybean producing areas.

The combination of the trends in yield and land prices provide useful information regarding the change in comparative advantage assuming other things remain constant. The combination of yield and land prices are the two most important variables in determining comparative advantage between the selected soybean producing areas. In Illinois area 300, there has been a decline in relative soybean yields

FIGURE 7. QUADRENNIAL TREND IN LAND PRICES IN THE SOYBEAN PRODUCING AREAS OF ILLINOIS, IOWA, MISSISSIPPI AND OHIO



but an even greater decline in relative land values compared to Iowa area 201. This combination of yield and land trends if continued in the future, will substantially improve the competitive position of Illinois area 300 in soybean production. In Iowa area 201, there has been a 2% per year rate of growth in soybean yields. In this area, nominal land values have appreciated about 15% per year during this same period of time. This combination of yield and land trends if continued in the future, will decrease the competitive position of Iowa area 201 in soybean production particularly in relation to Illinois area 300. In Mississippi area 100, there has been a decline in relative soybean yields and an increase in relative land values compared to Iowa area 201. This combination of yield and land trends is mutually reinforcing, and if continued in the future, will substantially aggravate the marginal competitive position which exists in soybean production in Mississippi area 100. In Ohio area 101, there has been no change in relative soybean yields and a decrease in relative land values compared to Iowa area 201. This combination of yield and land trends, if continued in the future, will improve slightly the competitive position of Ohio area 101 in soybean production relative to Iowa area 201. Even declining land prices can maintain these trends as long as similar proportions are maintained. It is unlikely that these trends will be offset by lower costs in some other input category.

Preharvest variable costs represent the second most costly category of expenses after land costs in each of the selected soybean producing areas. Preharvest cost items include seed, nitrogen, phosphate, potash, herbicides and insecticides; fuel, lubrication, repairs and labor; other and general farm overhead. The cost per bushel for each of these items is presented in Table 46. In Illinois area 300, soybean producers have higher expenditures on herbicides, insecticides, fuel, repairs and labor and lower expenditure on seed and "other" compared to Iowa area 201. "Other" item is lower in Illinois area 300 because it does not include expenditures on custom tillage, cultivation and planting, as is the case in Iowa area 201. In Iowa area 201, the most costly preharvest expenditures per bushel of soybeans, include fuel, repairs and labor; herbicides and insecticides and seed in that order. In Mississippi area 100, soybean producers have substantially higher expenditures on fuel repairs and labor and herbicides and insecticides and lower expenditures on phosphate potash and other (custom tillage cultivation and planting) compared to Iowa area 201. The substantially higher expenditures on fuel, repairs and labor in Mississippi area 100 are related to a combination of size and number of machines and tractors and the times over the field particularly for land preparation and cultivation associated with the additional problems with weed control. In Ohio area 101, soybean producers have higher expenditures on herbicides and insecticides, potash and phosphate and lower expenditures on other (custom tillage, cultivation and planting) compared to Iowa area 201.

Capital ownership costs is the third largest soybean production cost category in all the selected areas. Capital ownership costs include depreciation, insurance, taxes and interest (opportunity cost) on machinery and tractors used for the field operations. These field operations include land preparation, cultivation, fertilizer and

Table 46. Preharvest Costs Per Bushel in Determining Comparative Advantage in Selected Soybean Producing Areas in 1983.

Preharvest Item	IL 300		IO 201		MS 100[1]		OH 101	
	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff
Seed	.25	-.05	.30	0	.35	.05	.30	0
Nitrogen	0	0	0	0	0	0	0	0
Phosphate	.05	0	.05	0	0	-.05	.15	.10
Potash	.05	0	.05	0	0	-.05	.30	.25
Pesticides	.55	.10	.45	0	.65	.20	.70	.25
Fuel, Repairs & Labor	.55	.05	.50	0	1.50	1.00	.50	0
Other	.10	-.15	.25		.15	-.10	.10	-.15
General Farm Overhead	.25	0	.25	0	.30	.05	.25	0
Total	1.80	-.05	1.85	0	2.95	1.10	2.30	.45

1. 1982 production data.

chemical application, planting, harvesting and hauling. See Table 47. In Illinois area 300, ownership expenditures are slightly higher for planting, harvesting and hauling compared to Iowa area 201. The difference in harvest and hauling ownership costs between Illinois area 300 and Iowa area 201 is related to the fact that in the latter area about 10% of the acreage is custom harvested, hauled and planted. In Iowa area 201, the most costly field operations include harvesting, and land preparation in that order. In Mississippi area 100, ownership expenditures are substantially higher for land preparation, cultivation, harvesting and hauling. The higher ownership cost for

Table 47. Capital Ownership Costs Per Bushel in Determining Comparative Advantage in the Selected Soybean Producing Areas in 1983.

Field Operation	IL 300		IO 201		MS 100[1]		OH 101	
	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff
Land Preparation	.30	0	.30	0	.70	.40	.30	0
Cultivation	.10	0	.10	0	.50	.40	.05	-.05
Fert/Chem Appl.	.05	0	.05	0	.05	0	.10	.05
Planting	.15	.05	.10	0	.15	.05	.15	.05
Harvesting	.60	.05	.55	0	.80	.25	.70	.15
Hauling	.15	.05	.10	0	.30	.20	.10	0
Total	1.35	.15	1.20	0	2.50	1.30	1.40	.20

1. 1982 production data.

these field operations is related to a combination of size and number of machines and tractors and to times over the field preparation associated in part with the additional problems with weed control. In addition, the average soybean harvester size in Mississippi area 100 is a self-propelled eight-row harvester compared to a self-propelled six-row harvester typically used in the other selected areas. In Ohio area 101, ownership expenditures are higher for harvesting, planting and fertilizer and chemical application and lower for cultivation compared to Iowa area 201. Again, the difference in ownership costs for the field operations between Ohio area 101 and Iowa area 201 is due to the custom planting and harvesting done in the latter.

4.3 Summary

In summary, in Illinois area 300 the slight comparative disadvantage (about 5%) relative to Iowa area 201 is related to higher expenditures on herbicides and insecticides and the higher price of land. The trends in relative yield and land value, if continued, indicate that the competitive position of soybean production in Illinois area 300 will improve substantially relative to Iowa area 201. Size economies exist for large enterprises only in this area and can be exploited to improve comparative advantage. The Herfindahl indices imply that producers are concentrating resources in the very large and large enterprise sizes.

In Iowa area 201, comparative advantage is related to the level of yield which is high relative to seed, herbicide, insecticide and fertilizer expenditures. Expenditures for custom tillage, cultivation, planting and harvesting contributed to substantially lower capital ownership costs in this area as well. The trends in relative yield and land values indicate that the competitive position of soybean production in Iowa area 201 will decrease in the future. Size economies exist for very large and large enterprises and can be exploited to improve comparative advantage in this area. The Herfindahl indices imply that producers are concentrating resources in the very large and large enterprise sizes. This is a substantial change from the present concentration of resources in medium and large enterprise sizes which currently exists.

In Mississippi area 100, the substantial lack of comparative advantage in soybean production relative to Iowa area 201 is the result of low yields and high expenditures on herbicides and insecticides as well as high ownership costs for durables for land preparation, cultivation, harvesting and hauling. The trends in relative yield and land values, if continued, indicate that the competitive position of soybean production in Mississippi area 100 will substantially decrease in the future. No size economies remain to be exploited in soybean production in this area. The Herfindahl indices indicate that resources are already concentrated in the very large enterprise size and will remain unchanged in the future.

Finally, in Ohio area 101, the slight lack of comparative advantage in soybean production relative to Iowa area 201 is the result of lower yields and higher expenditures on herbicides, insecticides, potash and phosphate. The trends in relative yield and land values indicate that the competitive position of soybean production in Ohio area 101 will improve slightly in the future. Size economies do not exist for very large relative to large and medium size soybean enterprise and can not be exploited to improve comparative advantage in this area. The Herfindahl indices imply that producers are concentrating resources in the very large and large enterprise sizes.

CHAPTER V

WHEAT

This section presents the particulars associated with size economies within and comparative advantage between the selected wheat producing areas. The selected producing areas, type of wheat grown and crop rotation practices followed are:

(1) Kansas area 100 - hard red winter wheat following fallow

(2) Montana area 200 - hard red spring wheat following fallow

(3) North Dakota area 200 - hard red spring wheat following crop

(4) Washington area 400 - white wheat following fallow.

For these wheat producing areas, analysis of size economies and comparative advantage is presented in terms of cost-of-production data and other estimated indices.

5.1 Size Economies in Wheat Production

The four measures or indicators of size economies are estimated according to the procedures outlined in the section on methodology. These indicators include production costs, utilization of harvesting equipment and static and dynamic Herfindahl production concentration indices. A summary of these indices is presented in Table 48 by enterprise size for each of the selected production areas. Table 49 presents the results of the scoring procedure.

In Kansas area 100, very large wheat enterprises have a cost

Table 48. The Indices Used to Determine Size Economies in the Selected Wheat Producing Areas in 1983.

State, Area & Enterprise Size	Total Cost per Bu. %	Enterprise Size Acres		Harvesting Equipment Full Utilization		Herfindahl Index	
		Mean	SD	Max.	Min.	Static 1/ %	Dynamic 2/ %
KS 100							
VL	100	3909	2947	20.6	4.1	100	17
L	112	1429	320	3.9	2.0	100	17
M	118	774	141	2.0	1.1	75	-7
MT 200							
VL	100	1577	1137	6.9	1.5	100	20
L	106	619	79	1.5	1.0	23	-12
M	110	421	69	1.0	.6	6	-31
ND 200							
VL	100	1283	371	3.5	1.6	100	47
L	95	630	128	1.6	.9	72	11
M	103	338	63	.9	.4	36	-8
WA 400							
VL	100	2388	627	6.2	3.7	100	3
L	118	1104	144	2.7	1.9	100	3
M	85	753	90	1.9	1.3	31	-2

1/ 1982 Herfindalh measures are normalized using the very large enterprise as the base.

2/ 1978 and 1982 Herfindahl incides are used to measure the change in concentration. The change can result from movement within and between size categories.

advantage over other size categories. All three size categories can fully utilize 1 or more self-propelled harvesters. The static Herfindahl index of production concentration in 1982 is greatest for the very large and large producers. The dynamic Herfindahl index of concentration from 1978 to 1982 is positive for the very large and large enterprises. Thus, productive resources in Kansas area 100 are concentrating in the large and very large enterpise size at the expense of medium and small (those below the 40th decile in size) enterprises sizes. The scoring results are 4-3-2 for very large,

Table 49. Scoring Table Used to Determine Size Economies in the Selected Wheat Producing Areas in 1982/83.

State, Area & Enterprise Size	Production Cost	Harvester Utilization	Herfindahl Static	Herfindahl Dynamic	Total
KS 100					
VL	+	+	+	+	4
L	-	+	+	+	3
M	-	+	+	-	2
MT 200					
VL	+	+	+	+	4
L	-	+	-	-	1
M	-	+	-	-	1
ND 200					
VL	-	+	+	+	3
L	+	+	+	+	4
M	-	-	-	-	0
WA 400					
VL	-	+	+	-	2
L	-	+	+	-	2
M	+	+	-	-	2

large and medium enterprises respectively. There is evidence to argue for the existence of size economies for very large enterprises relative to the large and medium size wheat production in Kansas area 100.

In Montana area 200, very large wheat enterprises also have a cost advantage. All three enterprise sizes can fully utilize 1 or more self-propelled harvesters. The static measure of production concentration in 1982 is greatest for the very large enterprises. The change in the concentration from 1978 to 1982 is positive only for the very large enterprise size. Thus, productive resources in Montana area 200 are concentrated in the very large enterprise size and the trend in resource concentration is toward these very large enterprises at the expense of large and medium size enterprises. The scoring results are 4-1-1 for the very large, large and medium size categories respectively. This provides strong evidence to argue for the existence of size economies for very large enterprises relative to large and medium sizes.

In North Dakota area 200, large size wheat enterprises have a cost advantage. Both very large and large enterprises can fully utilize 1 or more self-propelled harvesters and the static measure of production concentration in 1982 is greatest for these two size categories. The change in concentration from 1978 to 1982 is positive for both very large and large enterprise sizes. Thus productive resources appear to be concentrated in these enterprise sizes primarily and the trend in resource concentration is toward very large and large enterprises at the expense of medium (and small) enterprises. The scoring results are 3-4-0 for the very large, large, and medium size categories respectively. This provides evidence to argue for the existence of size economies for very large and large enterprises relative to medium size enterprises in North Dakota area 200.

In Washington area 400, medium size wheat enterprises appear to have a substantial cost advantage. Very large, large and medium producers can all fully utilize 1 or more self-propelled harvesters. Wheat producers in this area typically use either a "regular" or "hillside" harvester. The static measure of production concentration in 1982 is greatest for very large and large enterprises. The change in the relative production concentration from 1978 to 1982 is positive for both very large and large enterprises. Productive resources appear to be concentrated in the very large and large enterprise sizes and are quite stable under the current configuration of enterprise sizes. The scoring result is 2-2-2 for very large, large and medium enterprise categories respectively. Thus size economies in the production of wheat in Washington area 400 are very modest at best.

To better understand the source or absence of size economies, let us examine in some detail the components of the production cost measure. Total cost per unit of output is equal to the average total cost per acre divided by yield per acre. Table 50 summarizes production costs and yields by enterprise size for the selected wheat producing areas. Wheat yields in Kansas area 100 are nearly uniform across enterprise size. In Montana area 200 and North Dakota area 200 the very large enterprises have the greatest yield per acre. In Washington area 400 very large and large enterprises have lower yields on average than the medium enterprises. In fact, 1982 Census of Agriculture data reveals that very small and small enterprises have substantially higher yields than medium-size enterprises in this area. Thus wheat yields in Washington appear inversely related to enterprise size. This is because of the heterogeneous rainfall in this area combined with the fact that smaller enterprises tend to be in the higher rainfall belts. In the other selected areas, however, yield is only a slight source of size economies in wheat production.

Total cost per acre is the other category which may reveal the source or absence of size economies in wheat production. In Kansas area 100, Montana area 200 and Washington area 400, very large enterprises have an advantage in terms of total cost per acre relative to large and medium enterprises. But, in North Dakota area 200, very large enterprises have a total cost per acre disadvantage relative to large and medium enterprises.

Table 50. Production Costs and Yield by Enterprise Size in the Selected Wheat Producing Areas in 1983.

State, Area & Enterprise Size	Total Cost		Yield		Total Cost	
	$/Bu	%	Bu/acre	%	$/acre	%
KS 100						
VL	2.05	100	33.1	100	68	100
L	2.30	112	33.1	100	76	112
M	2.41	118	33.2	100	80	118
MT 200						
VL	2.77	100	31.1	100	86	100
L	2.94	106	29.9	96	88	102
M	3.05	110	29.2	94	89	103
ND 200						
VL	3.79	100	31.7	100	120	100
L	3.60	95	30.8	97	111	93
M	3.91	103	29.7	94	116	97
WA 400						
VL	3.26	100	39.9	100	130	100
L	3.86	118	39.9	100	154	118
M	2.76	85	47.8	120	132	102

Total cost per acre can be disaggregated into preharvest, harvest and capital ownership costs. See Table 51. Capital ownership costs are defined as depreciation, taxes, insurance and interest (opportunity cost) on machinery and tractors used in the production process. Except in North Dakota area 200, very large enterprises on average have lower capital ownership costs than large and/or medium enterprises. Variable harvest costs are nearly constant across enterprise sizes except in Kansas area 100 where very large enterprisese have an advantage. Preharvest costs are also nearly constant across enterprise sizes except in Washington area 400 where very large enterprises have an advantage.

Table 51. Preharvest, Harvest and Capital Ownership Costs by Enterprise Size in the Selected Wheat Producing Areas in 1983

State, Area & Enterprise Size	Total Cost[1]		Preharvest		Harvest		Ownerhip	
	$/acre	%	$/acre	%	$/acre	%	$/acre	%
KS 100								
VL	68	100	22	100	14	100	32	100
L	76	112	22	100	19	136	35	109
M	80	118	27	123	17	121	36	113
MT 200								
VL	86	100	34	100	12	100	40	100
L	88	102	32	94	10	83	46	115
M	89	103	36	106	10	83	43	108
ND 200								
VL	120	100	58	100	13	100	49	100
L	111	93	55	95	12	92	44	90
M	116	97	55	95	13	100	48	98
WA 400								
VL	130	100	53	100	19	100	58	100
L	154	118	68	128	18	100	68	117
M	132	102	61	115	18	95	53	91

1. Excluding land charge.

Preharvest costs can be disaggregated into associated cost components to get yet a clearer picture of relative costs between enterprises within the selected wheat producing areas. See Table 52. The preharvest costs across enterprise categories in Kansas area 100, Montana area 200 and North Dakota area 200 are very similar. In Washington area 400, large and medium enterprises have substantially higher preharvest variable costs. For medium enterprises in Washington area 400, this is related to the additional expense associated with herbicides and insecticides. For large enterprises in this area, the higher preharvest cost is related to the additional

Table 52. Preharvest Variable Costs Per Acre in Determining Size Economies in the Selected Wheat Producing Areas in 1983.

Item	Enterprise Size	Kansas 100		Montana 200		N. Dakota 200		Washington 400	
		$/acre	Diff	$/acre	Diff	$/acre	Diff	$/acre	Diff
Seed	VL	3	0	5	0	9	0	4	0
	L	3	0	5	0	8	-1	4	0
	M	3	0	5	0	7	-2	5	1
Fertilizer	VL	1	0	1	0	21	6	16	0
	L	1	0	5	4	16	-5	16	0
	M	3	2	7	6	16	-5	15	-1
Pesticides	VL	0	0	3	0	9	0	1	0
	L	0	0	3	0	8	-1	5	4
	M	1	1	3	0	7	-2	6	5
Fuel, Lub., & Labor, & Repairs	VL	11	0	17	0	11	0	13	0
	L	11	0	11	-6	15	4	24	11
	M	13	2	13	-4	17	6	16	3
Other	VL	1	0	1	0	2	0	2	0
	L	1	0	1	0	2	0	2	0
	M	1	0	1	0	2	0	2	0
General Farm Overhead	VL	6	0	7	0	6	0	17	0
	L	6	0	7	0	6	0	17	0
	M	6	0	7	0	6	0	17	0
Total	VL	22	0	34	0	58	0	53	0
	L	22	0	32	-2	55	-3	68	15
	M	27	5	36	2	55	-3	61	8

fuel, lubrication and repairs associated with an additional 40 horsepower used in land preparation.

Capital ownership costs can also be disaggregated into associated cost components. See Table 53. Capital ownership cost is the cost of durables used in land preparation, fertilizer and chemical application, planting, harvesting and hauling. In Kansas area 100 and Montana area 200, very large enterprises have lower ownership costs relative to large and medium enterprises. The harvesting ownership costs accounts for this difference in both areas. In North Dakota area 200, large enterprises enjoy a slight ownership cost advantage in land preparation, fertilizer and chemical application and harvesting. In Washington area 400, medium enterprises enjoy a slight ownership cost advantage in four of the five field operation categories. Large enterprises in Washington area 400 have substantially higher ownership costs relative to very large enterprises. Again this relates to the substantially larger tractor size used in land preparation by large enterprises.

Harvesting costs are an important component in explaining differences in costs by enterprise size in each of the selected wheat producing areas. See Table 54. In this table we include information on custom harvesting as well as producer harvesting by enterprise size. In Kansas area 100, custom harvesting is very important at each enterprise size. Further, very large enterprises in this area enjoy substantial pecuniary economies associated with lower custom harvest rates relative to large and medium enterprises. The longer length of the harvest season is such that custom harvesting is used extensively. In Montana area 200 custom harvesting is also important and contri-

Table 53. Ownership Costs Per Acre in Determining Size Economies in the Selected Wheat Producing Areas in 1983.

Field Operation	Enterprise Size	Kansas 100		Montana 200		N. Dakota 200		Washington 400	
		$/acre	Diff	$/acre	Diff	$/acre	Diff	$/acre	Diff
Land Preparation	VL	10	0	13	0	10	0	10	0
	L	10	0	10	-3	8	-2	18	8
	M	10	0	9	-4	11	1	9	-1
Fertilizer & Chemical Application	VL	0	0	1	0	4	0	3	0
	L	0	0	1	0	2	-2	4	1
	M	0	0	1	0	3	-1	1	-2
Planting	VL	6	0	6	0	5	0	6	0
	L	6	0	5	-1	5	0	8	2
	M	4	-2	6	0	4	-1	5	-1
Harvesting	VL	10	0	15	0	25	0	29	0
	L	13	3	25	10	23	-2	27	-2
	M	15	5	22	7	24	-1	27	-2
Hauling	VL	6	0	5	0	5	0	10	0
	L	6	0	5	0	6	1	11	1
	M	7	1	5	0	6	1	11	1
Total	VL	32	0	40	0	49	0	58	0
	L	35	3	46	6	44	-5	68	10
	M	36	4	43	3	48	-1	53	-5

buted to a lower combined harvest cost per acre and again is a source of pecuniary size economies. In North Dakota area 200 custom harvesting plays only a minor role accounting for only 5-10% of the acres harvested. A more important factor in determining harvesting costs in this area is the extent to which tractor drawn wheat combines are used. Very large enterprises use them less than large and medium enterprises. The result is a slight pecuniary diseconomy associated with the more expensive self-propelled combines in North Dakota area 200 given the current size configuration. In Washington area 400, custom harvesting is not used. However an important harvesting cost consideration is the extent to which regular and hillside combines are used. Very large enterprises use a higher proportion of regular combines which have a larger harvesting capacity and higher associated costs.

In summary, we can make the following statements regarding the source of size economies in the selected wheat producing areas. In Kansas area 100 the important factor relates to pecuniary size economies associated with custom harvest rates. In Montana area 200, size economies are the result of the combination of slightly higher yields, and lower costs again related to the use of custom harvesting. In North Dakota area 200 size economies for large enterprises relate to higher yield and lower ownership and harvest costs relative to very large and medium enterprises. In Washington area 400 size economies do not exist for very large enterprises relative to medium enterprises because of the substantial diseconomies associated with yield and the slightly higher ownership and harvesting costs. In Washington area 400, size economies for very large enterprises relative to large

Table 54. Harvest Costs Per Acre in the Selected Wheat Producing Areas in 1983.

State, Area & Enterprise Size	Custom Harvest		Producer Harvest[1]		Total Harvest Cost	
	%	$/acre	%	$/acre	%	$/acre
KS 100						
VL	53	12	40	29	99	19
L	39	26	54	29	93	28
M	32	25	61	29	93	28
MT 200						
VL	37	13	62	30	99	23
L	0	0	100	30	100	30
M	9	13	90	30	100	28
ND 200						
VL	9	19	90	29	99	28
L	7	18	92	27	99	27
M	5	26	94	26	99	26
WA 400						
VL	0	0	99	35	99	35
L	0	0	99	33	99	33
M	0	0	99	33	99	33

1. Includes fuel, lubrication, repairs, labor and ownership costs.

enterprises exist because of the substantially lower ownership costs of the very large enterprises in this area related to the difference in horsepower size for tractors used in land preparation particularly.

5.2 Comparative Advantage in Wheat Production

In the previous section we focused our attention exclusively on size economies within a production area. In this section we shift our focus to the comparative advantage in wheat production between areas. As described in the methodology section, production data by enterprise size are combined using the static relative Herfindahl index as a weight. To this information is added data on county level land prices from the 1982 Census of Agriculture (COA). Yield information is changed from COA to the Statistical Reporting Service (SRS) data on county level yield per planted area using a five year average. The overall objective for including comparative advantage is to provide a context within which to analyze size economies. The secondary objective of this subsection is to determine the source or explain the absence of comparative advantage between the selected production areas.

We begin by comparing the relationship between comparative advantage and size economies in the selected wheat producing areas. Refer to Table 55. In Kansas area 100, comparative advantage in producing wheat is equal to Washington area 400. Kansas area 100 also has the potential for increasing its comparative advantage relative to unexploited size economies which exist for large and very large enterprises. This area has a relatively low level of production concentration as measured by the static Herfindahl index. Finally there is little change in production concentration in this area. The relatively large average size of the wheat enterprise of about 2200 acres in Kansas area 100 implies that even though enterprises are larger on average across size categories, no one enterprise size dominates production in the area.

In Montana area 200, it is more costly to produce a bushel of wheat than in Kansas area 100. Size economies do, however, exist for very large enterprises. The average enterprise size in this area is about 1400 acres. The measure of production concentration is quite high which implies that in 1982 a substantial portion of total wheat

Table 55. The Relationship Between Comparative Advantage and Size Economies in the Selected Wheat Producing Areas in 1983.

State & Area	Total Cost[1/]		Size Economies	Relative Size Acres	Herfindahl	
	$/Bu	%			Static[2/][3/] Absolute	Dynamic[4/] %
KS 100	6.55	100	VL & L	2152	3,990-8	5
MT 200	7.65	117	VL	1352	21,190-8	9
ND 200	7.10	108	VL & L	893	6,330-8	21
WA 400	6.55	100	None	1613	29,420-8	2

[1/] Including land charge and 5-year average yield 1979-83.

[2/] State level measure for the three enterprise size categories.

[3/] Scientific notation (-8 means to move the decimal eight places to to the left).

[4/] Change in the state level measure between 1978 and 1982.

production is produced on very large enterprises and this trend in concentration continued between 1978 and 1982. This implies that producers in Montana area 200 are exploiting size economies as a strategy to remain competitive with lower cost wheat producing areas like Kansas area 100.

In North Dakota area 200, it is more costly to produce a bushel of wheat than in Kansas area 100. Size economies exist for very large and large enterprises in North Dakota area 200. The average enterprise size is about 900 acres. Production concentration is higher than in Kansas area 100 but substantially lower than either Montana area 200 or Washington area 400. This implies that no one enterprise size dominates production in this area. There has been a substantial increase in production concentration in North Dakota area 200 between 1978 and 1982 of about 5% per year. This implies that producers in this area have begun an effort to exploit size economies as a means of increasing their competitive situation in wheat production.

In Washington area 400, production costs to produce a bushel of wheat are about equal to those in Kansas area 100. Size economies within Washington area 400 are nearly fully exploited. The average enterprise size is about 1600 acres. The level of production concentration is the highest of any of the wheat producing areas studied. This implies that large and very large enterprise sizes dominate production in this area. There has been virtually no change in the level of production concentration between 1978 and 1982. This implies that producers in this area have probably rather fully exploited available size economies.

Let us turn our attention now to the objective of determining the source of or explaining the absence of comparative advantage between the selected wheat producing areas. The comparative advantage measure for a production area is based on the total production cost per unit of output of a representative enterprise associated with the 40th through 90th deciles of enterprise sizes. Production costs and yields for these representative enterprises for the selected wheat producing areas is presented in Table 56. These results indicate that Kansas area 100, and Washington area 400 have nearly the same average total cost per unit of output. Costs in Montana area 200 and North Dakota area 200 are higher. On the basis of yield, Washington area 400 has the highest five year average (1983-1979) at about 47 bu./acre. Montana area 200 has the lowest yield at about 20 bu./acre. On the basis of total production cost per acre Montana area 200 has the

Table 56. Comparative Advantage in Wheat Production in the Selected Areas in 1983.

State & Area	Total Cost[1]		Yield[2]		Total Cost[1]	
	$/Bu	%	Bu/acre	%	$/acre	%
KS 100	6.55	100	27.8	100	182	100
MT 200	6.75	103	19.7	71	133	73
ND 200	7.10	108	22.6	81	161	88
WA 400	6.55	100	46.6	168	306	168

1. Including land charge.

2. Average yield for the area from 1979-1983.

Table 57. A Summary of Five Year Average Wheat Yields in the Selected Areas.

State & Area	1981 Bu/ plant Ave.	1981-1974		1978 Bu/ plant Ave.	1981-1978		1974 Bu/ plant Ave.	1978-1974	
		%	% /yr.		%	% /yr.		%	% /yr.
KS 100	27.8	100	.2	26.7	100	1.4	27.4	100	-.6
MT 200	19.7	71	-2.9	21.2	79	-2.4	24.8	91	-3.6
ND 200	22.6	81	3.3	18.3	69	7.8	18.4	67	-.1
WA 400	46.6	168	2.2	38.5	144	7.0	40.4	147	-1.2

lowest and Washington area 400 has the highest.

The SRS data on yield per planted acre from 1972 to 1983 for these wheat producing areas show that yields in Kansas area 100 have remained nearly constant, decreased in Montana area 200 by about 3% per year and increased in North Dakota area 200 and in Washington area 400 by about 3% and 2% respectively. See Table 57 and Figure 8. Since 1978 wheat yields in North Dakota area 200 have increased substantially at a rate of about 8% per year. The overall rate of growth in wheat yields in North Dakota area 200 resulted in an increase in relative yield compared to Kansas area 100. Since 1978 wheat yields in Washington area 400 have increased at a rate of about 7% per year. The overall rate of growth in wheat yields in Washington area 400 resulted in an increase in relative yield compared to Kansas area 100.

It is helpful to compare the yield data with production data on rates of seed and fertilizer application. See Table 58. Recall that the wheat under consideration is hard red winter (HRW) in Kansas area 100 following fallow, hard red spring (HRS) in both Montana area 200 following fallow and North Dakota area 200 following crop and white wheat (WW) in Washington area 400 following fallow. A comparison of the rates of seed and fertilizer application reveals a substantial difference between the selected producing areas. In general, areas planting in October (such as Kansas area 100 and Washington area 400) require less seed on average than areas planting in May as is true in Montana area 200 and North Dakota area 200. October planted wheat has a longer time to allow for stooling which is not possible for May planted wheat. The seeding rates reflect this situation in the

FIGURE 8. FIVE-YEAR AVERAGE TREND IN WHEAT YIELDS IN SELECTED AREAS OF KANSAS, MONTANA, NORTH DAKOTA AND WASHINGTON

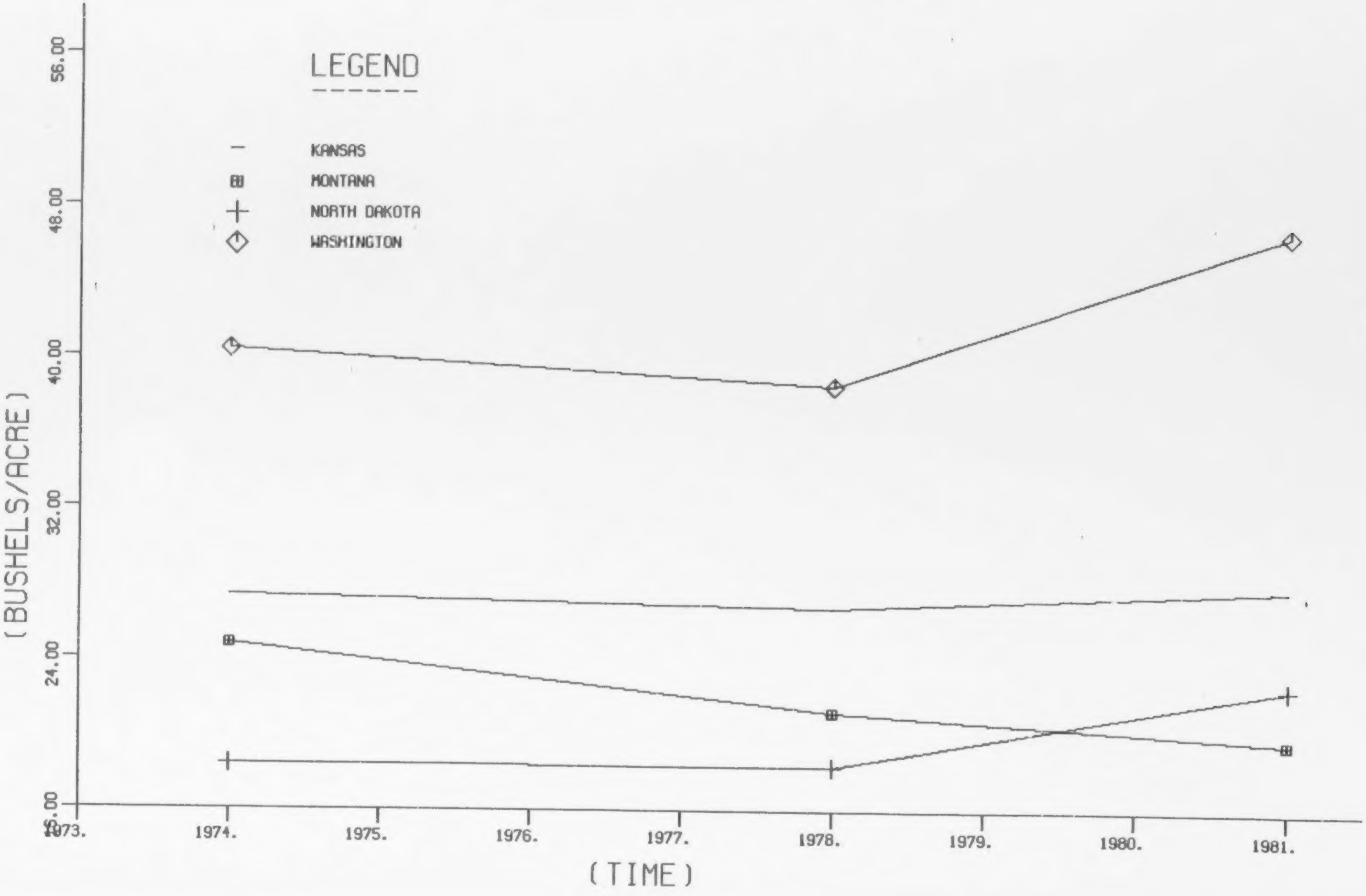


Table 58. Application Rates of Seed and Fertilizer in the Selected Wheat Producing Areas in 1983.

	KS 100		MT 200		ND 200		WA 400	
Input	lbs/bu/ acre	%	lbs/bu/ acre	%	lbs/bu/ acre	%	lbs/bu/ acre	%
Seed	35.7	-	61.2	63	97.4	100	45.1	-
Nitrogen	6.8	-	4.6	7	67.5	100	55.0	-
Phosphate	.3	-	3.0	11	26.3	100	2.5	-
Potash	0	-	0	0	1.3	100	0	-

respective areas. Further, in general wheat grown on land following fallow requires less nitrogen fertilizer than wheat grown on land following crop. Again this is reflected in the rates of nitrogen fertilizer application which is substantially more in North Dakota area 200 than in the other selected wheat producing areas.

Production costs per bushel can be disaggregated by associated cost categories. Table 59 provides a summary of preharvest, harvest, ownership and land costs by production area. For preharvest costs, the lowest is in Kansas area 100 and the highest is in North Dakota area 200. For variable harvest costs, the lowest is in Washington area 400 and the highest is in Kansas area 100 and Montana area 200. For ownership costs, the lowest is in Kansas area 100 and the highest is in Montana area 200 and North Dakota area 200. Finally for land charges, the lowest is in North Dakota area 200 and the highest cost is in Kansas area 100.

The land charge is the most costly single input in the production of wheat in all the selected producing areas comprising on average

Table 59. Production Costs Per Bushel in the Selected Wheat Producing Areas 1983.

State &	Total[1]		Preharvest		Harvest		Ownership		Land Charge[1]	
Area	$/Bu	%	$/Bu	%	$/Bu	%	$/Bu	%	$/Bu	%
KS 100	6.55	100	.85	100	.60	100	1.20	100	3.90	100
MT 200	7.65	117	1.70	200	.60	100	2.10	175	3.25	60
ND 200	7.10	108	2.45	288	.55	92	2.10	175	2.00	51
WA 400	6.55	100	1.30	153	.40	67	1.35	113	3.50	90

1. 10% of 1982 land values (double in areas fallowing including KS 100, MT 100 and WA 400).

about 50% of the cost of inputs assuming a 10% return on 1982 land prices. The land charge is particularly costly in those areas requiring summer fallow including Kansas area 100, Montana area 200 and Washington area 400. The fallowing practice essentially doubles the land charge by requiring land be held out of production during one production period. Fallowing may be viewed as a substitute for fertilizer, irrigation and herbicides. This cultural practice and the associated land charge are important factors in determining comparative advantage. Table 60 summarizes the average county level nominal land values in the selected production areas at four year intervals associated with the Census of Agriculture survey years 1974, 1978 and 1982. These data are presented graphically in Figure 9. Between 1982 and 1974, land values in Kansas area 100 increased by about 13 percent per year. In Montana area 200, land values have increased at about 10% per year from 1974 to 1982. This rate of appreciation in nominal land values has resulted in a decrease in

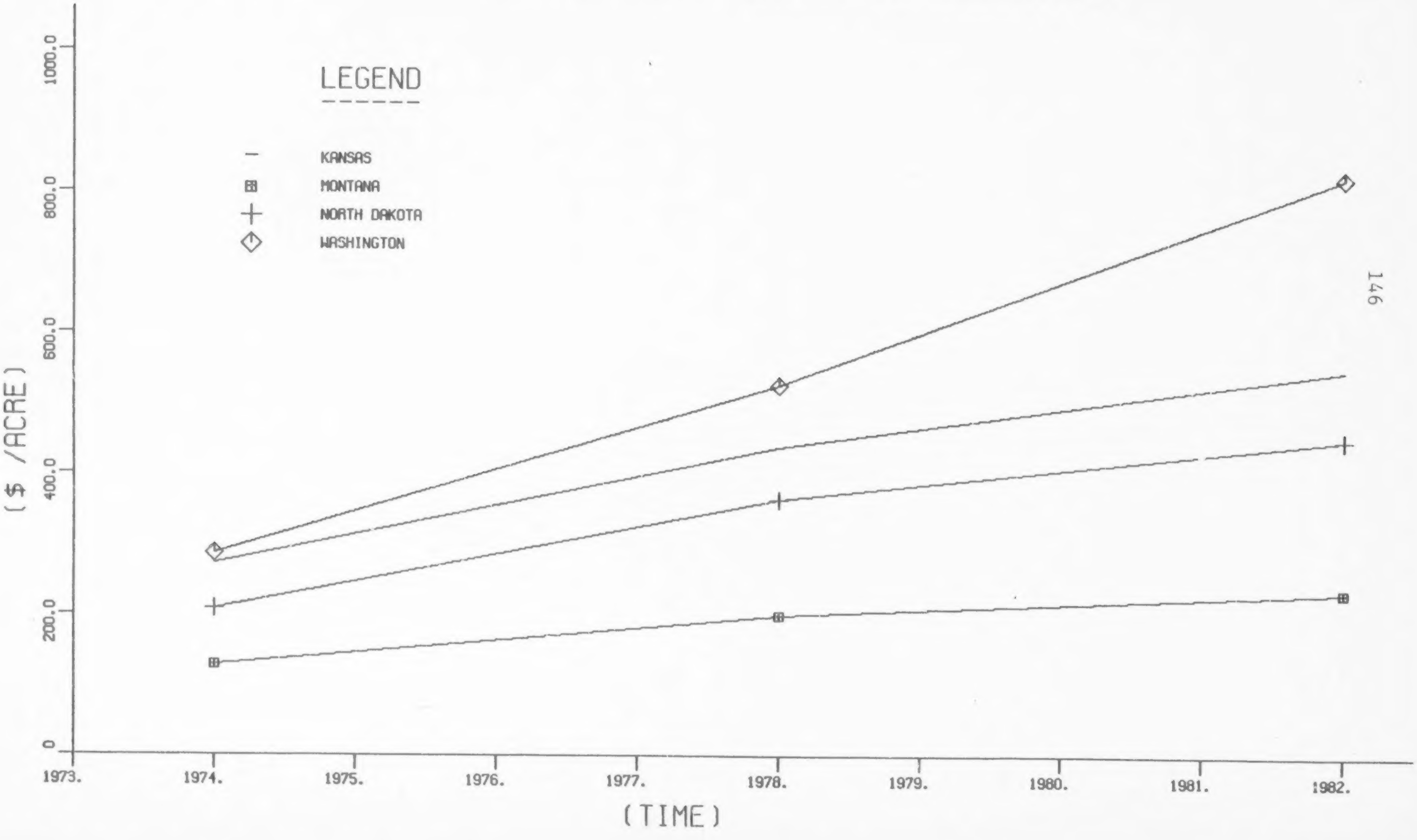
Table 60. Land Values Per Acre in the Selected Wheat Producing Areas in 1974, 1978 & 1982.

State & Area	1982		1982-74	1978		1982-78	1974		1978-74
	$/acre	%	% /yr	$/acre	%	% /yr	$/acre	%	% /yr
KS 100	546	100	12.6	437	100	6.2	272	100	15.2
MT 200	232	42	10.0	199	46	4.1	129	47	13.6
ND 200	448	82	14.3	363	83	5.9	209	77	18.4
WA 400	818	150	23.3	524	120	14.0	286	105	20.8

relative land values in Montana area 200 compared to Kansas area 100. In North Dakota area 200, nominal land values have increased at about 14% per year form 1974 to 1982. This rate of appreciation has the net result of a decrease in relative land values in North Dakota area 200 compared to Kansas area after the difference between the fallow and continuous cropping practices are taken into account. In Washington area 400, nominal land values have increased at about 23% per year from 1974 to 1982. This rate of appreciation has resulted in an increase in relative land values in Washington area 400 compared to Kansas area 100. Even declining land prices can maintain these trends as long as similar proportions are maintained. It is unlikely that these trends will be offset by changes in costs in some other input categories.

The combination of the trends in yield and land prices provide useful information regarding trends in comparative advantage assuming other things remain constant. In Kansas area 100 there has been no significant increase in wheat yields and a substantial increase in

FIGURE 9. QUADRENNIAL TREND IN LAND PRICES IN THE WHEAT PRODUCING AREAS OF KANSAS, MONTANA, NORTH DAKOTA AND WASHINGTON



land values between 1974 and 1982. This combination of trends, if continued, will decrease the comparative advantage enjoyed in Kansas area 100. In Montana area 200, relative wheat yields have decreased more than land prices compared to Kansas area 100. This combination of yield and land trends if continued into the future will decrease the overall competitive position of Montana area 200 in wheat production. In North Dakota area 200, relative wheat yields have increased while relative land prices have decreased slightly compared to Kansas area 100 after account is taken for cultural practices. If these trends in relative yield and land prices continue in the future other things being equal, then the competitive position of North Dakota area 200 will improve compared to Kansas area 100. In Washington area 400, relative wheat yields have increased in proportion to land prices compared to Kansas area 100. If these trends in relative yield and land prices continue, other things being equal, then the competitive position of Washington area 400 will remain relatively unchanged compared to Kansas area 400.

Preharvest costs represent a category of items with substantial variation between the selected wheat producing areas. The preharvest cost items include seed; fertilizer; herbicides and insecticides; fuel, lubrication, repairs and machinery labor; other and general farm overhead. The cost per bushel for each of these items is presented in Table 61. In Kansas area 100 the major items of preharvest cost are for fuel, lubrication, repairs and labor and general farm overhead. In Montana area 200, expenditures on fuel, lubrication, repairs and labor are substantially higher than in Kansas area 100. Higher preharvest variable costs associated with preharvest field operations are related to some combination of more and smaller machines and tractors going over the field more times. In North Dakota area 200, expenditures on seed, nitrogen, phosphate and herbicides and insecticides are substantially higher in Kansas area 100. These additional yield related expenses can be explained by the fact that additional seed, fertilizer and chemical area required to maintain the increasing relative yields in North Dakota area 200. Further spring wheat following crop, as is the case in North Dakota area 100, needs additional seed to offset the increase in stooling enjoyed by winter wheat production as in the other producing areas. Finally additional fertilizer and chemicals are needed on land follow another crop which is not necessary for land which has been fallow the previous production period again as is the case in the other selected wheat producing areas. In Washington area 400 expenditures on nitrogen are substantially higher than in Kansas area 100.

Capital ownership costs are a large cost category with relatively low variability across the selected wheat producing areas. Capital ownership costs include depreciation, insurance, taxes and interest (opportunity cost) on durables associated with particular field operations. These operations include land preparation, fertilizer and chemical application, planting, harvesting and hauling. See Table 62. In Kansas area 100 capital ownership costs are greatest for land preparation and harvesting. In Montana area 200 relative ownership costs are greatest in land preparation and harvesting. The higher harvesting ownership costs in Montana area 200 are related to lower proportion of custom harvesting in this area. In North Dakota area 200, relative ownership costs are greatest in harvesting compared Kansas

Table 61. Preharvest Costs Per Bushel in Determining Comparative Advantage in the Selected Wheat Producing Areas in 1983.

Preharvest Item	KS 100		MT 200		ND 200		WA 400	
	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff
Seed	.10	0	.25	.15	.35	.25	.10	0
Nitrogen	.05	0	.05	0	.50	.45	.30	.25
Phosphate	0	0	.05	.05	.30	.30	0	0
Potash	0	0	0	0	0	0	0	0
Pesticide	0	0	.15	.15	.35	.35	.10	.10
Fuel/Repairs/ Labor	.45	0	.80	.35	.60	.15	.40	-.05
Other	.05	0	.05	0	.10	.05	.05	0
Gen'l Farm Overhead	.20	0	.35	.15	.25	.05	.35	.15
Total	.85	0	1.70	.85	2.45	1.60	1.30	.45

Table 62. Capital Ownership Costs Per Bushel in Determining Comparative Advantage in the Selected Wheat Producing Areas in 1983.

Field Operation	KS 100		MT 200		ND 200		WA 400	
	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff	$/Bu	Diff
Land Prep.	.35	0	.65	.30	.40	.05	.30	-.05
Fert/Chem. Appl.	0	0	.05	.15	.15	.15	.10	.10
Planting	.20	0	.30	.10	.25	.05	.15	-.05
Harvesting	.40	0	.90	.50	1.05	.65	.60	.20
Hauling	.25	0	.20	-.05	.25	0	.20	-.05
Total	1.20	0	2.10	.90	2.10	.90	1.35	.15

area 100. As in Montana area 200, the higher harvesting ownership costs in North Dakota area 200 are related to a substantially lower proportion of custom harvesting compared to Kansas area 100. In Washington area 400, relative ownership costs are not substantially different for any of the field operations compared to Kansas area 100.

5.3 Summary

In summary, in Kansas area 100 comparative advantage is related to a level of yield which is high relative to fertilizer, herbicide and insecticide use. The trends in relative yield and land values, if continued, indicate that comparative advantage in this area will decrease in relation to Washington area 400. However, size economies in Kansas area 100 have not been full exploited and can be used to maintain comparative advantage. The Herfindahl indices imply that producers are concentrating resources in the very large and large enterprise sizes at the expense of medium and small enterprise sizes.

In Montana area 200, the lack of comparative advantage relative to Kansas area 100 is related to high ownership costs associated with more and smaller machines and tractors going over the land more times in land prepration as well as higher harvesting ownership costs. The trends in relative yield and land values are such that a substantial decline in the comparative advantage is possible in this area in the future. Size economies still exist for very large enterprises in Montana area 200 and can be further exploited in the future to maintain comparative advantage. The Herfindahl indices show that resource concentration is increasing in very large size category at the expense of the large and medium enterprise sizes.

In North Dakota area 200, the lack of comparative advantage relative to Kansas area 100 is related to the additional expenditures on seed, fertilizer and chemicals associated with increasing relative yields, spring planting and continuous cropping. The area also has high harvesting ownership costs. The trend in relative yield and land values indicate that the comparative advantage of wheat production in North Dakota area 200 will improve relative to Kansas area 100. Size economies can also be exploited in this area to improve comparative advantage. The Herfindahl indices reveal an increase in resource concentration in the very large and large enterprise size categories at the expense of the medium and small sizes.

In Washington area 400, the presence of comparative advantage relative to Kansas area 100 is related to substantially greater yields with only proportional increases in preharvest and ownership costs. Expenditures on nitrogen fertilizer are substantially higher in Washington area 400 than in Kansas area 100. The trends in relative wheat yields and land values are offsetting. Therefore other things being equal comparative advantage between Washington area 400 and Kansas area 100 will remain unchanged. Should the comparative advantage in Washington area 400 begin to decline, there are no size economies to further exploit given the yield diseconomies which predominate. The Herfindahl indices show that resources concentration is stable and greatest in the very large and large enterprise size categories.

CHAPTER VI

RICE

This section presents the particulars associated with size economies within and comparative advantage between the selected rice producing areas. The producing areas and type of rice grown include:

1.	California area 400	medium and short grain rice
2.	Texas area 1001	long grain rice
3.	Delta (Mississippi 100 and Arkansas 300)	long grain rice
4.	Arkansas area 200	long grain rice

For those producing areas an analysis of size economies and comparative advantage is presented in terms of production data and other estimated indices.

6.1 Size Economies in Rice Production

The four measures or indicators of size economies are estimated according to the procedures outlined in the section on methodology. These indicators include production costs, utilization of harvesting equipment as well as static and dynamic Herfindahl production concentration indices. A summary of these indices is presented in Table 63 by enterprise size for each of the selected production areas. Table 64 presents the results of the scoring procedure.

In California area 400, the total cost per hundredweight of rice for all three enterprise sizes is nearly identical with medium size

Table 63. Indices Used to Determine Size Economies in Selected Rice Producing Areas in 1979

State, Area & Enterprise Size	Total cost per cwt.	Enterprise Size acres		Harvester full utilization		Herfindahl Indices	
	%	Mean	S.D.	max	min.	Static[1/] %	Dynamic[2/] %
CA 400							
VL	100	3575	1175	11.7	4.7	100	-4
L	99	1503	377	4.6	2.4	100	-4
M	97	870	151	2.4	1.3	25	-19
TX 1001							
VL	100	2068	380	6.2	3.7	100	28
L	96	1049	143	2.8	1.8	80	24
M	97	691	111	1.8	1.1	61	20
DLT 100 and 300							
VL	100	1904	790	6.5	2.2	100	-35
L	94	853	259	3.3	1.0	85	-19
M	92	509	115	1.5	.6	58	11
AK 200							
VL	100	1619	623	6.3	2.1	100	21
L	100	720	179	2.1	1.0	84	-20
M	96	377	57	1.0	.6	67	-7

1/ 1982 Herfindahl measures are normalized using the very large enterprise as the base.

2/ 1978 and 1982 Herfindahl indices are used to measure the change in concentration. This change can result from a movement within and between size categories.

enterprises having a slight cost advantage. Each enterprise size can fully utilize the capacity of 1 or more self-propelled harvesters. This harvester is assumed to have an annual harvesting capacity of 465 acres. The 1982 static Herfindahl measure of production concentration is greatest for the very large and large producers. The dynamic Herfindahl index of the change in concentration from 1978 to 1982 is negative for all enterprise sizes. Productive resources in California

Table 64. Scoring Table Used to Determine Size Economies in the Selected Rice Producing Areas in 1979

State, Area & Enterprise Size	Production Cost	Harvester Utilization	Herfindahl Indices		Total
			Static	Dynamic	
CA 400					
VL	−	+	+	−	2
L	−	+	+	−	2
M	+	+	−	−	2
TX 1001					
VL	−	+	+	+	3
L	+	+	−	+	3
M	+	+	−	+	3
DLT 100 and 300					
VL	−	+	+	−	2
L	+	+	−	−	2
M	+	+	−	+	3
AK 200					
VL	−	+	−	+	2
L	−	+	−	−	1
M	+	+	−	−	2

area 400 are concentrated in the very large and large enterprise size. The trend however is toward slightly less resource concentration. The scoring results are 2-2-2 for very large, large and medium size enterprises, respectively. Thus there is evidence of little or no size economies in California area 400 rice production given the 1979 configuration of enterprise sizes.

In Texas area 1001, large rice enterprises have a slight cost advantage. Each enterprise size can fully utilize the capacity of 1 or more self-propelled harvesters. The static measure of concentration is greatest for very large enterprises. The change in concentration is also greatest for very large enterprises. The production resources in Texas area 1001 are concentrated in the very large enterprise size.

The trend in resource concentration is toward the very large, large and medium enterprise sizes at the expense of small enterprises (those below the 40th decile in size). The scoring results are 3-3-3 for the very large, large and medium size categories, respectively. This suggests that no significant size economies exist in Texas area 1001 rice production given the 1979 configuration of enterprise sizes.

In the Delta areas 100 and 300, medium size enterprises have a cost advantage. Each enterprise can fully utilize the capacity of 1 or more self-propelled harvesters. This harvester is assumed to have an annual harvesting capacity of 495 acres per harvester. The static measure of concentration indicates that production is concentrated in very large enterprises. The change in the relative concentration from 1978 to 1982 is positive for the medium enterprise size only. Productive resources in the Delta areas 100 and 300 are concentrated in the very large enterprise size. Yet the modest trend is toward medium size enterprises at the expense of very large and large enterprises. The scoring results are 2-2-3 for the very large, large and medium size enterprises respectively. This evidence indicates that no size economies exist in the Delta areas 100 and 300 rice production given the 1979 configuration of enterprise sizes. In fact there is evidence which suggests diseconomies of size given the enterprise configuration in 1982.

In Arkansas area 200, medium size enterprises have a cost advantage. Each enterprise can fully utilize the capacity of 1 or more self-propelled harvesters. The static measure of production concentration in 1982 is greater for very large enterprises. The change in production concentration from 1978 to 1982 is positive for the very large enterprise size only. Productive resources are concentrated in very large enterprise and the trend is for continued concentration in this size category at the expense of large and medium enterprise sizes. The scoring results are 2-1-2 for the very large, large and medium size enterprises, respectively. Overall, available avidence suggests that no size economies exist in Arkansas area 200 rice production given the 1979 configuration of enterprise sizes.

To better understand the absence of size economies in rice production, let us examine in some detail the components of the production cost measures. Total cost per unit of output is equal to total cost per acre divided by yield per acre. Table 65 summarizes the production costs and yield by enterprise size for the selected rice producing areas. Rice yields in all the production areas studied are inversely related to enterprise size except in Texas area 1001. In the case of the Delta areas 100 and 300 large and medium rice enterprises have a rather substantial yield advantage relative to very large enterprises. Total cost per acre for very large enterprises in all the production areas is less than or equal to total cost for large and medium enterprises again except in Texas area 1001. In general, rice production has diseconomies of size relative to yield and no economies of size in relation to total costs per acre. Yield diseconomies are related in large part to timeliness of fertilizer and water application which can be managed at smaller enterprise sizes.

The total cost per acre (excluding land charge) can be disaggregated into preharvest, harvest and capital ownership costs as presented in Table 66. Preharvest costs of medium size rice enterprises are consistently lower than those for very large enterprises in all

Table 65. Production Costs and Yield by Enterprise Size in the Selected Rice Producing Areas in 1979

State, Area and	Total Cost		Yield		Total Cost	
Enterprise Size	$/cwt	%	cwt/acre	%	$/acre	%
CA 400*						
VL	6.34	100	51.3	100	325	100
L	6.29	99	52.6	103	331	102
M	6.12	97	52.1	102	319	98
TX 1001						
VL	7.70	100	47.4	100	365	100
L	7.39	96	46.3	98	342	94
M	7.46	97	46.4	98	346	95
DLT 100-300*						
VL	6.78	100	39.8	100	270	100
L	6.36	94	42.6	107	271	100
M	6.26	92	43.6	110	273	101
AK 200*						
VL	6.33	100	43.1	100	273	100
L	6.31	100	44.7	104	282	103
M	6.09	96	44.5	103	271	99

*irrigated

the selected production areas. This is particularly important in light of the fact that yields generally tend to be higher for the medium size enterprises. Variable harvesting costs are quite high but do not appear to consistently advantage one enterprise size over another across the selected production areas. Capital ownership costs are defined as depreciation, taxes, insurance and interest (opportunity cost) on machinery and tractors used in the production process. Ownership costs per acre for very large enterprises are lower than those for large and medium size enterprises in all the selected production areas except in Texas area 1001. In general, ownership cost size economies offset preharvest cost diseconomies such

Table 66. Preharvest, Harvest and Capital Ownership Costs by Enterprise Size in the Selected Rice Producing Areas in 1979

State, Area & Enterprise Size	Total Cost1/		Preharvest		Harvest		Ownership	
	$/acre	%	$/acre	%	$/acre	%	$/acre	%
CA 400*								
VL	325	100	181	100	70	100	74	100
L	331	102	184	102	71	101	76	103
M	319	98	177	98	74	106	68	92
TX 1001*								
VL	365	100	227	100	65	100	73	100
L	342	94	210	93	62	95	70	96
M	346	95	213	94	64	98	69	95
DLT 100-300*								
VL	270	100	160	100	57	100	53	100
L	271	100	156	98	57	100	58	109
M	273	101	157	98	56	98	60	113
AK 200*								
VL	273	100	158	100	52	100	63	100
L	282	103	159	101	57	110	66	105
M	271	99	151	96	56	108	64	102

1/ Excluding land charge.
*Irrigated.

total cost per acre exhibits slight size economies in all the production areas except in Texas area 1001.

Preharvest costs can be disaggregated into associated cost components to get yet a clearer picture of relative costs between enterprise sizes within the selected rice producing areas. Refer to Table 67. In California area 400, the lower preharvest cost of medium size enterprises is related to the substantially lower fertilizer use and its custom application cost which is only partially offset by higher herbicide, insecticide and fungicide and its custom application costs. In Texas area 1001, the lower preharvest costs of medium and

Table 67. Preharvest Variable Costs per Acre in Determining Size Economies in Selected Rice Producing Areas in 1979

Item	Enterprise Size	California 400		Texas 1001		Delta 100 and 300		Arkansas 200	
		$/acre	Diff.	$/acre	Diff.	$/acre	Diff.	$/acre	Diff.
Fertilizer and Application	VL	44	0	46	0	31	0	32	0
	L	40	-4	43	-3	27	-4	33	1
	M	29	-15	46	0	29	-2	30	-2
Seed and Application	VL	32	0	22	0	25	0	24	0
	L	33	1	24	2	22	-3	22	-2
	M	32	0	22	0	20	-5	23	-1
Pesticide	VL	22	0	48	0	35	0	30	0
	L	28	6	32	-16	34	-1	31	1
	M	28	6	35	-13	34	-1	24	-6
Fuel, Lubrication, Repair & Labor	VL	28	0	33	0	20	0	26	0
	L	31	3	36	3	25	5	28	2
	M	29	1	31	-2	25	5	26	0
Irrigation	VL	28	0	58	0	31	0	27	0
	L	23	-5	47	-11	31	0	27	0
	M	30	2	48	-10	31	0	27	0
Other	VL	8	0	12	0	9	0	10	0
	L	10	2	20	8	8	-1	9	-1
	M	10	2	23	11	9	0	12	2
General Farm Overhead		19	0	8	0	9	0	9	0
Total	VL	181	0	227	0	160	0	158	0
	L	184	3	210	-17	156	-4	159	1
	M	177	-4	213	-14	157	-3	151	-7

large enterprises is related to the substantially lower costs of herbicide, insecticide, fungicide and their application as well as lower variable cost irrigation expenses. This is partially offset by higher 'other' costs including 'other' labor. In the Delta areas 100 and 300, the lower preharvest costs of medium and large enterprises are related to lower cost of fertilizer and seed and their custom application. In Arkansas area 200, the lower preharvest costs of medium size enterprises is related to lower costs of seed, fertilizer, herbicide, insecticide, fungicide and their custom application. In general, yields are higher for medium size enterprise, and their preharvest costs including seed, fertilizer and herbicides, insecticides and fungicides are lower. Timeliness of application appear to be more important in enhancing rice yields than absolute quantity of these yield enhancing variable inputs. Management, then appears to be a source of size diseconomies in rice production in that smaller enterprises appear to have a better control over timeliness of these inputs than larger enterprises.

Capital ownership costs can also be disaggregated into associated cost components. See Table 68. Capital ownership costs of rice production are defined as depreciation, taxes, insurance and interest (opportunity cost) on tractors and machinery used in land preparation, ditching, harvesting, hauling and irrigation. Harvesting equipment is the most costly single ownership field operation across all production areas. The variation in ownership costs within a production area is related to the use of custom harvesting and the ratio of planted to harvested acres. Irrigation ownership costs are less costly than harvesting ownership costs but are subject to cost variability within a

Table 68. Ownership Costs per Acre in Determining Size Economies in the Selected Rice Producing Areas in 1979

Item		California 400		Texas 1001		Delta 100 and 300		Arkansas 200	
		$/acre	Diff.	$/acre	Diff.	$/acre	Diff.	$/acre	Diff.
Land Preparation	VL	11	0	15	0	7	0	11	0
	L	14	3	14	-1	9	2	12	1
	M	13	2	12	-3	9	2	11	0
Ditching	VL	6	0	5	0	3	0	5	0
	L	5	-1	10	5	5	2	6	1
	M	5	-1	6	1	6	3	5	0
Fertilizer/ Chem/Seed Application	VL	1	0	1	0	1	0	2	0
	L	1	0	0	-1	1	0	2	0
	M	1	0	0	-1	1	0	2	0
Irrigation	VL	4	0	10	0	10	0	10	0
	L	2	-2	5	-5	11	1	10	0
	M	3	-1	8	-2	11	1	10	0
Harvesting	VL	30	0	23	0	20	0	20	0
	L	30	0	23	0	20	0	20	0
	M	30	0	23	0	20	0	20	0
Hauling	VL	22	0	19	0	12	0	15	0
	L	24	2	18	-1	12	0	16	1
	M	16	-6	20	1	13	1	16	1
Total	VL	74	0	73	0	53	0	63	0
	L	76	2	70	-3	58	5	66	3
	M	68	-6	69	-4	60	7	64	1

production area associated with purchased water which is analogous to custom harvesting. These two cost categories are interesting because each is a potential source of pecuniary size economics. In order to compare custom harvest costs with producers' harvest costs it is necessary to include along with capital ownership cost the cost of fuel, lubrication, repairs and labor. See Table 69. In each production area the custom harvest rate is very similar to the producers' total harvest cost as might be expected. In California area 400, where custom harvesting charges are less than producer harvest costs on average, a larger percentage of custom harvesting is used. Finally, there seems to be a pattern of pecuniary economies associated with custom harvesting such that larger enterprises pay a lower custom rate/acre. The overall effect of pecuniary size economics associated with custom harvesting of rice is very slight. The 120% harvesting times over in Texas area 1001 reflects a first and second harvest of rice in this area.

In California area 400 and Texas area 1001, a substantial amount of purchased canal water is used to produce rice. See Table 70. In both of these areas purchased canal water is much less costly than pumped well water. In Texas area 1001, the price of purchased canal water is somewhat less costly for large and medium enterprises than for the very large size enterprises. In California area 400, the reverse is true. These two particular examples are presented in some detail because the presence of their respective pecuniary economies and diseconomies can only be revealed by close comparison of the effect of custom rates on overall production costs of these inputs.

Table 69. Harvesting Costs Per Acre in the Selected Rice Producing Areas in 1979

State, Area and Enterprise Size	Custom Harvested		Producer Harvested[1/]		Total Harvest Cost	
	%	$/acre	%	$/acre	%	$/acre
CA 400						
VL	26	46	72	48	98	47
L	5	47	93	48	98	48
M	11	49	89	48	100	48
TX 1001						
VL	0	0	120	31	120	31
L	0	0	120	31	120	31
M	0	0	120	31	120	31
DLT 100 and 300						
VL	21	35	78	32	99	33
L	8	50	90	32	98	34
M	1	48	98	32	99	33
AK 200						
VL	7	38	92	32	99	32
L	0	0	99	32	99	32
M	1	35	99	32	100	32

[1/] Includes fuel, lubrication, repair, labor and ownership costs.

In summary, slight size diseconomies in rice production exist uniformally across the selected production area. These diseconomies are primarily the result of yield diseconomies of size particularly in California area 400, the Delta area 100 and 300 and Arkansas area 200. Yield diseconomies are related to timeliness of fertilizer, herbicide, insecticide, fungicide and water application on leveled land. In Texas 1001, there are size diseconomies associated with purchased canal water used for irrigation.

Table 70. Irrigation Costs in the Selected Rice Producing Areas in 1979

State, Area and Enterprise Size	Purchased Water		Well Water[1]		Total Water Cost	
	acre-in	$/ acre-in	acre-in	$/ acre-in	acre-in	$/ acre-in
CA 400						
VL	41	.37	16	.72	57	.47
L	49	.33	8	.72	57	.38
M	45	.44	12	.72	57	.50
TX 1001						
VL	30	.99	20	1.58	50	1.23
L	39	.79	11	1.58	50	.96
M	34	.77	16	1.58	50	1.03
DLT 100 & 300						
VL	0	0	43	.77	43	.77
L	0	0	43	.77	43	.77
M	0	0	43	.77	43	.77
AK 200						
VL	0	0	25	1.17	25	1.17
L	0	0	25	1.17	25	1.17
M	0	0	25	1.17	25	1.17

1/Includes fuel, lubrication, repair, labor and ownership costs.

6.2 Comparative Advantage in Rice Production

In the previous section we focused our attention exclusively on size economics within a production area. In this section we shift our attention to the comparative advantage in rice production between areas. As described in the methodology section, production cost data by enterprise size are combined using the static relative Herfindahl index as a weight. To this information is added data on county level land prices from the 1978 Census of Agriculture (COA). Yield information is changed from COA to the USDA's Statistical Reporting Service (SRS) data on county level yield per planted acre using a five year moving average over the period 1977 to 1983. The overall objective for including comparative advantage is to provide a context within which to analyze size economies. The secondary objective of this subsection is to determine the source or explain the absence of comparative advantage between the selected production areas.

We begin by comparing the relationship between comparative advantage and size economics in the selected rice producing areas. Refer to Table 71. In California area 400, the comparative advantage in rice production is the greatest of the areas studied. This comparative advantage is not extendable through size economies since size economies have been rather fully exploited in this area. California area 400 has the largest average size rice acreage per enterprise at about 1,100 acres. The static Herfindahl index is quite high compared to Arkansas area 200 but less than the Delta areas 100 and 300. This implies that production is concentrated in the very large and large enterprise sizes. This is consistent with the notion that size economies have already been rather fully exploited in this area. The dynamic Herfindahl index shows that there has been a decrease in production concentration between 1978 and 1982. This implies that rice production became less concentrated and may continue to do so in the future if size economies is the sole source of economic incentives for very large units. The combination of size economy and comparative advantage information together shows that rice enterprises in California area 400 should not increase in size as a means of reducing cost and thereby improving comparative advantage.

In Texas area 1001, the comparative disadvantage in producing rice is the greatest of the areas studied. This comparative disadvan-

Table 71. The Relationship Between Comparative Advantage and Size Economies in the Selected Rice Producing Areas in 1979

State & Area	Total Cost		Size Economies	Relative Size acres	Herfindahl	
	$/cwt	%			Static absolute	Dynamic %
CA 400	7.60	100	none	1071	164,040-8	-7
TX 1001	9.50	124	none	802	130,280-8	25
DLT 100 & 300	8.70	114	none	694	227,960-8	-22
AK 200	8.20	108	none	485	35,000-8	-3

tage is not correctable by increasing enterprise size in attempting to be more competitive since size economies have already been rather fully exploited. The average enterprise size in this area is about 800 acres. This is equal to the full utilization of the capacity of 1 or more self-propelled rice harvesters. The static Herfindahl index is high relative to Arkansas area 200 but less than the selected areas in California and the Delta. This implies that production is concentrated in the very large enterprise size. The dynamic Herfindahl index shows that there has been an increase in production concentration between 1978 and 1982. This change in concentration may be the result of marginal producers exiting from this industry leaving only the more highly specialized larger producers in rice production as they continue to depreciate durable assets with very low salvage value. (This explanation is supported by the fact that there are 66 fewer rice enterprises in 1982 than in 1978 for a decline of about 15% in these enterprise categories. In all other rice producing areas the overall number of enterprises increased between 1978 and 1982.)

In the Delta areas 100 and 300, the comparative disadvantage in 1979 is such that it is more costly to produce a hundredweight of rice than in California area 400. This comparative disadvantage is not correctable by simply increasing enterprise size in an attempt to be more competitive since size economies have already been more than fully exploited. The average enterprise size in this area is about 700 acres. This is equal to the full utilization of the capacity of 1 or more self-propelled rice harvester. The static Herfindahl index is the highest of the selected rice producing areas. This implies that production is concentrated in the very large enterprise size category. The dynamic Herfindahl index shows that there has been a substantial trend away from the very large enterprise size between 1978 and 1982. Rice production in the absence of size economies is becoming less concentrated and many continue to do so into the future as well. The combination of the size economy and comparative advantage information together implies that rice enterprises in the Delta areas 100 and 300 could not increase size as a means of enhancing comparative advantage.

In Arkansas area 200, the comparative advantage to produce a hundredweight of rice is slightly less than in California area 300. This comparative disadvantage is not correctable by increasing enterprise size in an attempt to be more competitive since size economies do not exist. The average enterprise size in this area is about 485 acres, the smallest of the selected rice producing areas. This is equal to the full utilization of the capacity of about 1 self-propelled rice harvester. The static Herfindahl index is the lowest of the selected producing areas. Productive resources are less concentrated in this area than any of the other selected rice areas.

The dynamic Herfindahl index is positive for the very large enterprise size. The combined information on size economies and comparative advantage implies that rice enterprises in Arkansas area 200 could not increase in size to enhance comparative advantage. In fact, the current size distribution of rice enterprise are well suited for rice production by being medium-size on average.

Let us turn our attention to the objective of determining the source or explaining the absence of comparative advantage between the selected rice producing areas. The comparative advantage for a production area is based on the total production cost per unit of output of a composite representative enterprise associated with the 40th through 90th deciles of enterprise sizes. The production costs and yields for these representative enterprises for the selected rice producing areas are presented in Table 72. These results indicate that California area 400 has the lowest production cost per unit of output. Arkansas area 200 and the Delta areas 100 and 300 have the next lowest production costs. Texas are 1001 has the highest production costs per unit of output. California has a substantially higher average yield. High yielding short and medium grain rice is grown in California area 400 whereas the lower yielding long grain rice is grown in the other areas. The Delta areas 100 and 300 has the lowest average yield. California area 400 has the highest production costs per acre while the Delta areas 100 and 300 and Arkansas area 200 have the lowest.

The SRS data on yield per planted acre from 1977 to 1983 for the selected rice producing areas show that yield in California area 400 has increased substantially between 1979 and 1981 at a rate of about 4% per year. This is based on a five year moving average. See

Table 72. Comparative Advantage in Rice Production in the Selected Areas in 1979

State & Area	Total Cost[1/]		Yield[2/]		Total Cost[1/]	
	$/cwt	%	cwt/acre	%	$/acre	%
CA 400	7.60	100	62.3	100	476	100
TX 1001	9.50	124	45.9	74	436	92
DLT 100 & 300	8.70	114	40.6	65	355	75
AK 200	8.20	108	43.2	69	355	75

1/ Includes a 10% land charge on 1978 land values.

2/ 5-year average center on 1979.

Table 73 and Figure 10. In Texas area 1001, the Delta areas 100 and 300 and Arkansas area 200, the relative rice yields are substantially lower than those in California area 400 because of the difference in the type of rice grown. Further, the trends in absolute rice yields have been slightly negative from 1979 to 1981 for those three rice producing areas. As a result yields in California area 400 increased substantially in both absolute and relative terms between 1979 and 1981.

It is helpful to compare yield data with production data on rates of seed and fertilizer application. See Table 74. To allow for a clearer comparison across producing areas, the application rates for seed and fertilizer are presented in terms of pounds per hundredweight. The application rate for seed in California area 400 and Texas area 1001 are similar. Both areas plant rice by means of custom application from the air. In the Delta areas 100 and 300 and in

Table 73. A Summary of Five Year Average Rice Yields in the Selected Areas

State & Area	1981[a]		1979-1981 % yr	1979[b]	
	cwt/acre	%		cwt/acre	%
CA 400	66.8	100	3.6	62.3	100
TX 1001	45.2	68	-0.8	45.9	74
DLT 100 & 300	40.4	60	-0.3	40.6	65
AK 200	42.9	64	-0.4	43.2	69

a/ Five-year average from 1979 to 1983.

b/ Five-year average from 1977 to 1981.

Arkansas area 200 the rate of seed application is higher than in California area 400. This difference is the result of planting long grain rice on the heavy soil of the Delta and Arkansas. Nitrogen application is greater than in California area 400. In sum, California area 400 appears to have a comparative advantage in terms of initial resource endowments the production of rice.

To provide greater insight into the source of comparative advantage in rice production we can disaggregate production cost per cwt. into associated cost categories. Table 75 provides a summary of preharvest, harvest, ownership and land charge per cwt. in the selected rice producing areas. In preharvest costs, the lowest cost is in California area 400 and the highest is in Texas area 1001. In variable harvest costs, the lowest cost is in California area 400 and the highest is in Texas area 1001 and Arkansas area 200. In land charges, the lowest costs are in Texas area 1001 and Arkansas area 200 and the highest is in California area 400.

FIGURE 10. FIVE-YEAR AVERAGE TREND IN RICE YIELDS IN SELECTED AREAS OF CALIFORNIA, TEXAS, MISSISSIPPI AND ARKANSAS

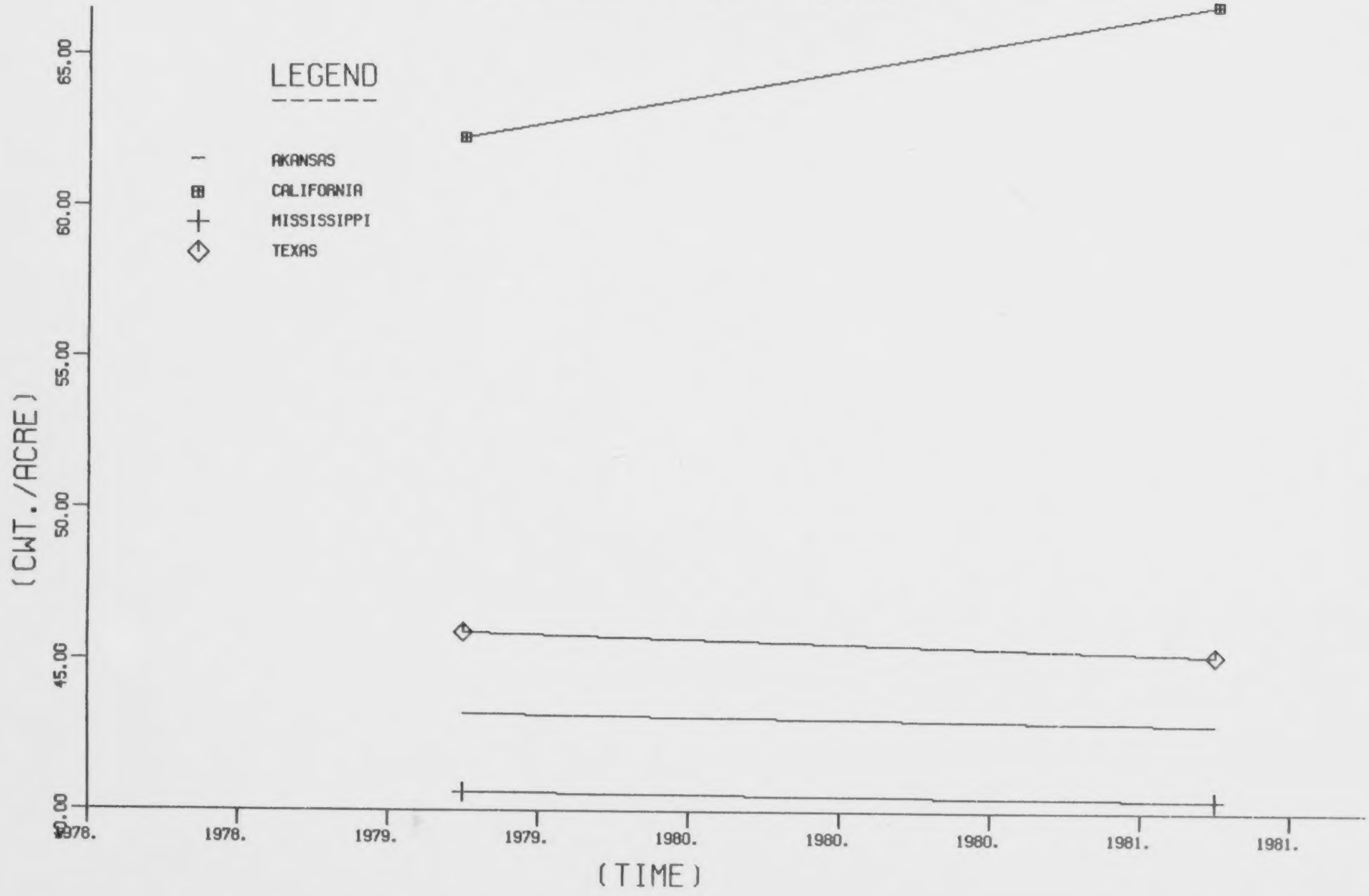


Table 74. Application Rates of Seed and Fertilizer in the Selected Rice Producing Areas in 1979

	CA 400[1/] lbs/cwt		TX 1001[2/] lbs/cwt		DLT 100 and 300[2/] lbs/cwt		AK 200 [2/] lbs/cwt	
Input	acre	%	acre	%	acre	%	acre	%
Seed	2.4	100	2.7	113	3.5	146	3.5	146
Nitrogen	1.8	100	3.1	172	3.0	167	2.7	150
Phosphate	.7	100	1.3	186	.1	14	.2	29
Potash	.1	100	.7	700	.2	200	.5	500

1/ Short and medium grain rice.

2/ Long grain rice.

Table 75. Production Costs per Cwt. in the selected Rice Producing Areas in 1979

State and Area	Total[1/]		Preharvest		Harvest		Ownership		Land charge[1/]	
	$/cwt.	%	$/cwt.	%	$/cwt.	%	$/cwt.	%	$/cwt.	%
CA 400	7.60	100	2.90	100	1.10	100	1.20	100	2.40	100
TX 1001	9.50	125	4.80	166	1.40	127	1.50	125	1.80	75
DLT 100-300	8.70	114	3.90	134	1.40	127	1.40	117	2.00	83
AK 200	8.20	108	3.60	124	1.30	118	1.50	125	1.80	75

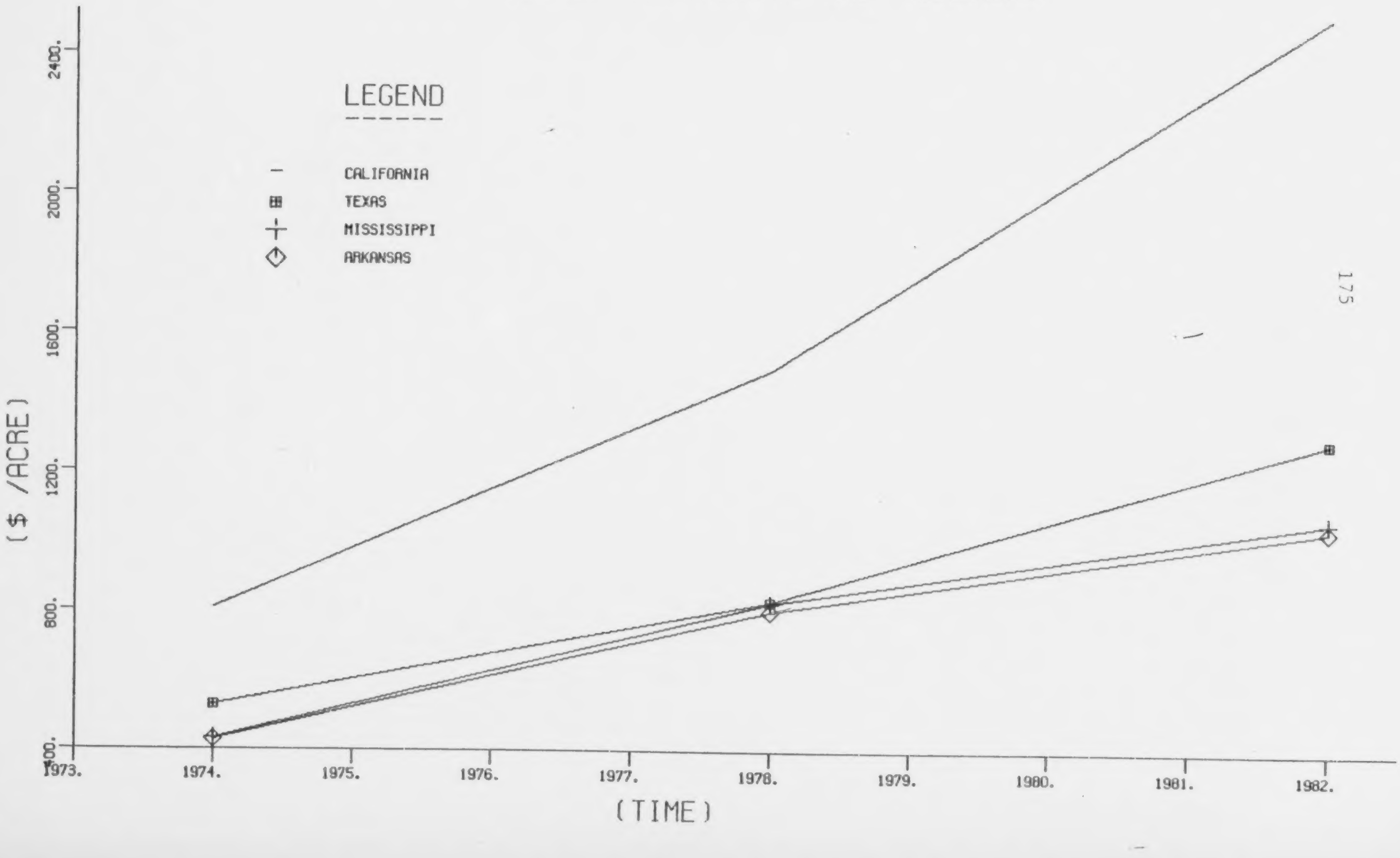
1/ Includes 10% rate of return on 1978 land values.

Table 76. Land Values Per Acre in the Selected Rice Producing Areas in 1974, 1978 & 1982

State and Area	1982		1982-74	1978		1982-78	1974		1978-74
	$/acre	%	% /yr	$/acre	%	% /yr	$/acre	%	% /yr
CA 400	2507	100	26.2	1492	100	17.0	809	100	21.1
TX 1001	1294	52	18.1	830	56	14.0	528	65	14.3
DLT 100 & 300	1064	42	18.4	825	55	7.2	431	53	22.9
AK 200	1041	42	17.9	801	54	7.5	428	53	21.9

The land charge is the most costly single item in the enterprise budget comprising on average about 25% of the cost of inputs assuming a 10% return to 1978 land values. A change in relative land prices can have a substantial impact on comparative advantage in rice production. Table 76 summarizes the average county level nominal land values in the selected rice producing areas at four year intervals associated with the COA survey years of 1974, 1978 and 1982. These data are also presented graphically in Figure 11. In California area 400, nominal land values appreciated at a rate of about 17% per year between 1978 and 1982. In Texas area 1001, nominal land values appreciated at a rate of about 14% per year from 1978 to 1982. This rate of appreciation in nominal land values in Texas area 1001, resulted in a slight decrease in relative land values compared to California area 400. In the Delta areas 100 and 300, nominal land prices appreciated at an annual rate of about 7% from 1978 to 1982. This rate of appreciation in nominal land values in the Delta areas 100 and 300 resulted in a substantial decrease in relative land values compared to

FIGURE 11. QUADRENNIAL TREND IN LAND PRICES IN THE RICE PRODUCING AREAS OF CALIFORNIA, TEXAS, MISSISSIPPI AND ARKANSAS



California area 400. In Arkansas area 200, nominal land prices appreciated at an annual rate of about 8% from 1978 to 1982. This rate of appreciation in nominal land values in Arkansas area 200 also resulted in a substantial decrease in relative land prices compared to California area 400. Even declining land prices can continue these trends as long as similar proportions are maintained.

The combination of relative rice yield and land trends provide some insight in the change in comparative advantage in the future if these trends continue, other things being equal. In California area 400 rice yields have increased at a rate of about 4 %/year while nominal land values have appreciated at a rate of about 17%/year between 1978 and 1982. In Texas area 1001, relative rice yields have decreased while relative land values have decreased by less. If these trends continue, then the competitive position of rice production in Texas area 1001 will decrease from an already marginal position. In the Delta areas 100 and 300 and in Arkansas area 200 relative rice yields have decreased while relative land values have decreased even more than yields. If these trends continue, then the competitive position of rice production in the Delta areas 100 and 800 and in Arkansas area 200 should decrease slightly relative to California area 400.

Preharvest costs are the single largest cost category in the select rice producing areas in 1979. The items in this category include expenditures on seed, fertilizer, chemicals, fuel, repairs and machinery labor, irrigation, other and general farm overhead. See Table 77. In California 400, the largest expenditures in this category are on fertilizer, fuel, repairs and labor and seed. In

Table 77. Preharvest Costs Per Cwt in Determining Comparative Advantage the Selected Rice Producing Areas in 1979

Preharvest Item	CA 400		TX 1001		DLT 100 and 300		AK 200	
	$/cwt	Diff	$/cwt	Diff	$/cwt	Diff	$/cwt	Diff
Seed	.50	0	.50	0	.50	0	.50	0
Fertilizer	.70	0	1.00	.30	.70	0	.80	.10
Pesticides	.40	0	.90	.50	.90	.50	.70	.30
Fuel, Repairs & Labor	.50	0	.70	.20	.60	.10	.60	.10
Irrigation	.40	0	1.10	.70	.80	.40	.60	.20
"Other"	.10	0	.40	.30	.20	.10	.20	.10
Geneneral Farm Overhead	.30	0	.20	-.10	.20	-.10	.20	-.10
Total	2.90	0	4.80	1.90	3.90	1.00	3.60	.70

Texas area 1001, the largest additional expenditure on these items compared to California area 400 is on irrigation and chemicals. Variable irrigation costs are substantially more expensive in Texas area 1001 because purchased water is about 2-3 times more expensive per acre-inch than in California area 400. Variable costs associated with well pumped water is also greater in Texas area 1001 because average pumping lift is 2-3 times higher than in California area 400. The additional expenditure in Texas area 1001 on chemicals is related to the addition use of herbicide and fungicides which is above that spent California area 400 for these items. In the Delta area 100 and 300, the largest additional expenditure on preharvest items is on also on chemicals and irrigation. The additional expenditure on chemicals in the Delta area 100 and 300 is related to the additional use of herbicides and fungicides which is above that spent in California area 400 for these items. The substantially higher variable costs associated with irrigation relate to the fact that the entire supply of water for rice production in the Delta area 100 and 300 is pumped from wells which is about 3-4 times the average number of acre inches pumped from wells in California area 400. In Arkansas area 200, the additional expenditures on preharvest items are greatest for chemicals and irrigation. The additional expenditure on chemicals in this area is related to additional use of herbicides and fungicides which is partially offset by a lower use of insecticides. The result is an additional expenditure on chemicals in Arkansas area 200 compared to California area 400. The additional expenditure on irrigation in Arkansas area 200 is related to the fact that all irrigation water is pumped from wells at a substantially higher total cost per acre-inch than in California area 400. This situation is partially offset by the fact that less than half as many acre-inches of water are used in Arkansas area 200 as in California area 400 in rice production.

Capital ownership costs is one of the lowest cost categories in rice production in the select areas and it has the least variation between areas. See Table 78. Capital ownership cost is the depreciation, insurance, taxes and interest (opportunity cost) on durables used in various field operations. These field operations include land preparation, ditching, fertilizer, chemical and seed application, irrigation, harvesting and hauling. In California area 400, the capital ownership expense is related to harvesting, hauling, land preparation and ditching in that order. Irrigation ownership cost is a very

Table 78. Capital Ownership Costs Per Cwt in Determining Comparative Advantage in the Selected Rice Producing Areas in 1979

Preharvest	CA 400		TX 1001		DLT 100 and 300		AK 200	
Item	$/cwt	Diff	$/cwt	Diff	$/cwt	Diff	$/cwt	Diff
Land Preparation	.20	0	.30	.10	.20	0	.30	.10
Ditching	.10	0	.10	0	.10	0	.10	0
Fertilizer, Chem., Planting	0	0	0	0	0	0	0	0
Irrigation	0	0	.20	.20	.30	.30	.30	.30
Harvesting	.50	0	.50	0	.50	0	.50	0
Hauling	.40	0	.40	0	.30	-.10	.30	-.10
Total	1.20	0	1.50	.30	1.40	.20	1.50	.30

minor expenditure since nearly all irrigation water for rice production in California area 400 is purchased. Further, water that is pumped from wells in this area requires a relatively shallow lift. The additional capital ownership cost in the other producing areas relates almost entirely to the difference in ownership costs associated with pumping irrigation water. In these other producing areas the lift required is higher, and/or the percentage of well pumped water is greater.

6.3 Summary

In summary, in California area 400, the comparative advantage in rice production is a result of high yields for short and medium grain rice and relatively inexpensive irrigation water and reduced herbicide and fungicide costs relative to the other selected long-grain rice producing areas. If the 1978/79 trends in relative yield and land values continue, then California area 400 will remain unchanged in comparative advantage. The size diseconomies of yield preclude increasing enterprise size as a means of lowering production costs. The Herfindahl indices show that resources are concentrated in very large and large enterprises. The trend however in resource concentration away from very large, large and medium enterprises and toward smaller enterprise sizes. Projections of comparative advantage using 1982 yield and land prices with 1979 costs are presented in Table 79.

In Texas area 1001, the comparative disadvantage in rice production is related to relatively low yields and high irrigation, herbicide and fungicide costs compared to California area 400. If trends in relative yield and land values continue, other things being equal, then Texas area 1001 will decline from its already marginal competitive position. Size diseconomies associated with irrigation water and chemicals preclude increasing enterprise size as a means of lowering production costs. The Herfindahl indices imply that resources are concentrated in very large and large enterprise sizes. The trend in resource concentration is toward very large, large and medium enterprise size at the expense of smaller enterprise sizes.

In the Delta area 100 and 300, the moderate comparative disadvantage in rice production is related to the additional expenditure on herbicides, fungicides and irrigation water compared to California area 400. If trends in relative yields and land values continue, other things being equal, then the Delta areas 100 and 300 will

Table 79. Comparative Advantage in Rice Production in the Selected Areas in "1982"

State & Area	Total Cost1/		Yield2/		Total Cost1/	
	$/cwt	%	$/acre	%	$/acre	%
CA 400	8.59	100	66.8	100	574	100
TX 1001	10.62	124	45.2	68	480	84
DLT 100 and 300	9.38	109	40.4	60	379	66
AK 200	8.81	103	42.9	64	378	66

1/ Including land charge based on 1982 land values.

2/ Average yield for the area from 1979 to 1983.

decrease slightly in its competitive position. Size diseconomies of yield preclude increasing enterprise size as a means of further reducing production costs. The Herfindahl indices imply that resources are concentrated in very large enterprise sizes. The trend in resource concentration is toward medium size enterprises at the expense of very large and large enterprises.

In Arkansas area 200, the moderate comparative disadvantage in rice production is related to the additional expenditure on herbicides, fungicides and well pumped irrigation water compared to California area 400. If trends in relative yields and land values continue, other things being equal, then Arkansas area 200 will decrease slightly in its competitive position. Finally size diseconomies of yield preclude increasing enterprise size as a means of further reducing production costs. The Herfindahl indices show that resources are concentrated in very large enterprise sizes at the expense of large and medium enterprise sizes.

The slight decrease in the comparative advantage in rice production in Mississippi and Arkansas is currently being altered by the adoption of a new high yielding, short strawed variety called "Lamont" introduced in 1984. This new technology may substantially improve the comparative advantage of these long-grain rice producing areas.

CHAPTER VII

COTTON

This section presents the particulars associated with size economies within and comparative advantage between the selected upland cotton producing areas. The producing areas and cultural practices include:

1.	Alabama area 600	dryland
2.	California area 500	irrigated
3.	Mississippi area 100	primarily dryland
4.	Texas area 200*	irrigated
5.	Texas area 200	dryland

For these cotton producing areas analysis of size economies and comparative advantage is presented in terms of cost-of-production data and other estimated indices.

7.1 Size Economies in Cotton Production

The four measures or indicators of size economies are estimated according to procedures outlined in the section on methodology. These indicators include production costs, utilization of harvesting machinery as well as static and dynamic Herfindahl production concentration indices. A summary of these indices is presented in Table 80 by enterprise size for each of the selected production areas. Table 81 presents the results of the scoring procedure.

Table 80. Indices Used to Determine Size Economies in Selected Cotton Producing Areas in 1982

State, Areas & Enterprise Size	Total Cost per Bale %	Enterprise Size Acres		Harvesting Equipment Full Utilization		Herfindahl Indices	
		Mean	S.D.	Max.	Min.	Static[1/] %	Dynamic[2/] %
AL 600							
VL	100	1842	725	6.7	2.9	100	63
L	107	917	97	2.6	2.1	64	8
M	108	568	73	1.8	1.3	64	8
CA 500*							
VL	100	2833	816	9.3	5.2	100	39
L	91	1432	283	4.2	2.3	100	39
M	98	624	183	2.0	.9	6	9
MS 100							
VL	100	2868	1100	11.3	5.2	100	24
L	103	1202	380	5.1	2.3	100	24
M	100	754	96	2.3	1.6	48	21
TX 200*							
VL	100	1707	435	4.7	2.5	100	77
L	94	929	204	2.4	1.3	70	80
M	99	436	89	1.1	.6	35	80
TX 200							
VL	100	5920	5406	29.5	5.8	100	6
L	114	1825	397	5.0	2.7	100	6
M	117	972	237	2.7	1.4	51	5

*irrigated

1/ 1982 Herfindahl measures are normalized using the very large enterprise as the base.

2/ 1978 and 1982 Herfindahl indices are used to measure the change in concentration. The change can result from movement within and between size categories.

Table 81. Scoring Table Used to Determine Size Economies in the Selected Cotton Producing Areas in 1982

State, Area and Enterprise Size	Production Costs	Harvester Utilization	Herfindahl Indices		Total
			Static	Dynamic	
AL 600					
VL	+	+	+	+	4
L	−	−	+	−	1
M	−	−	+	−	1
CA 500*					
VL	−	+	+	+	3
L	+	+	+	+	4
M	−	+	−	−	1
MS 100					
VL	+	+	+	+	4
L	+	+	+	+	4
M	+	+	−	+	3
TX 200*					
VL	−	+	+	+	3
L	+	+	+	+	4
M	−	+	−	+	2
TX 200					
VL	+	+	+	−	3
L	−	+	+	−	2
M	−	+	−	−	1

*irrigated

Among the different size categories in Alabama area 600, very large cotton enterprises have the lowest total cost per bale and they can fully utilize 1 or more self-propelled 2-row cotton pickers. This size harvester is assumed to have an annual harvesting capacity of about 390 acres per harvester. The static Herfindahl measure of production concentration in 1982 is greatest for the very large producers. The dynamic Herfindahl index of the change in concentration from 1978 to 1982 is positive for each enterprise size. Productive resources in Alabama area 600 are concentrated in the very large enterprise size. The scoring results are 4-1-1 for very large, large and medium size enterprises, respectively. There is strong evidence to argue that size economies exist for very large cotton enterprises in Alabama area 600.

In California area 500, large cotton enterprises have the lower total cost per bale. Each enterprise size can fully utilize 1 or more self-propelled 2 row cotton pickers. This size harvester is assumed to have an annual harvesting capacity of about 460 acres per harvester in this area. The static Herfindahl concentration index is greatest for the very large and large enterprises. The dynamic Herfindahl concentration index is positive for each enterprise size. Thus, productive resources in California area 500 are concentrated in the very large and large enterprise sizes. The scoring results are 3-4-1 for very large, large and medium size enterprises, respectively. This provides evidence to argue that size economies for very large enterprises in the production of irrigated cotton in California area 500 are very modest at best given the enterprise configuration in 1982.

In Mississippi area 100, the total cost per bale is nearly constant across cotton enterprise size categories. Each enterprise size can fully utilize 1 or more self-propelled, 2-row cotton pickers. This size harvester is assumed to have an annual harvesting capacity of 378 acres. The static Herfindahl concentration index in 1982 is greatest for very large and large enterprise sizes. The dynamic Herfindahl concentration index from 1978 to 1982 is also nearly constant across all enterprise sizes. Productive resources in Mississippi area 100 are concentrated in the very large and large enterprise sizes. The scoring results are 4-4-3 for very large, large and medium size enterprises, respectively. Thus it appears that size economies for very large cotton enterprises in Mississippi area 100 are quite modest given the enterprise configuration in 1982.

In Texas area 200 (irrigated) large cotton enterprises have the lowest total cost per bale. Each enterprise size can fully utilize 1 or more cotton strippers with an assumed annual harvesting capacity of about 527 acres per harvester. The measure of relative production concentration in 1982 is greatest for very large enterprises. The change in relative production concentration from 1978 to 1982 is nearly constant across enterprise size categories. But, the trend in resource concentration is toward larger enterprises at the expense of small enterprises (those below the 40th decile in size). The scoring results are 3-4-2 for very large, large and medium enterprises, respectively. Thus, there is evidence to argue that size economies for very large enterprises in irrigated cotton in Texas area 200 are modest at best given the 1982 configuration of enterprises.

In Texas area 200 (dryland) very large cotton enterprises have the lowest total cost per bale. Each enterprise size can fully utilize 1 or more cotton strippers with an assumed annual harvesting capacity of 474 acres per harvester. The measure of relative production concentration in 1982 is greatest for very large and large enterprises. The change in relative production concentration from 1978 to 1982 is positive, nearly constant and quite small across enterprise sizes. Resource concentrations appear quite stable under the current configuration of enterprise sizes. The scoring results are 3-2-1 for very large, large and medium enterprises respectively. As a result, one can argue that size economies exist for very large enterprises in dryland cotton production in Texas area 200.

To better understand the circumstances regarding size economies in the selected cotton producing areas, let us examine in some detail the components of the production costs measures. Total cost per bale is equal to total cost per acre divided by yield per acre. Table 82 summarizes the production costs and yields by enterprise size for the selected areas. Cotton yields in general are nearly constant across enterprise size. Total costs per acre are also nearly constant across enterprises in Alabama area 600, Mississippi area 100 and Texas area 200 (irrigated). In California area 500 total cost per acre is highest for the very large enterprises while in Texas area 200 (dryland) the total cost per acre is inversely related to enterprise size.

Table 82. Production Costs and Yield by Enterprise Size in the Selected Cotton Producing Areas in 1982

State, Area & Enterprise Size	Total Cost[1/]		Yield		Total Cost[1/]	
	$/bale	%	bales/acre	%	$/acre	%
AL 600						
VL	279	100	1.52	100	424	100
L	298	107	1.47	97	438	103
M	301	108	1.47	97	443	104
CA 500*						
VL	298	100	2.28	100	680	100
L	271	91	2.28	100	619	91
M	291	98	2.11	93	613	90
MS 100						
VL	230	100	1.79	100	412	100
L	237	103	1.79	100	424	103
M	229	100	1.74	97	399	97
TX 200*						
VL	319	100	.67	100	214	100
L	299	94	.69	103	206	96
M	315	99	.68	102	214	100
TX 200						
VL	259	100	.44	100	114	100
L	298	114	.45	103	134	118
M	302	117	.45	102	136	119

*irrigated

1/ Excluding land charge.

Total cost per acre (excluding land charge) can be disaggregated into preharvest, harvest and capital ownership costs as presented in Table 83. Preharvest costs are lower for large and medium enterprise relative to very large enterprises in Alabama area 600, and California area 500. In Mississippi area 100 and Texas area 200 (irrigated) preharvest costs are nearly uniform across enterprise sizes. In Texas area 200 (dryland) preharvest cost for very large enterprises are substantially lower than for large and medium enterprises. Within all areas, variable harvest costs are nearly constant across enterprise size. Capital ownership cost for very large enterprises are less in Alabama area 500 and Texas area 200 (dryland) and more in California area 500 and Texas area 200 (irrigated) relative to large and medium enterprises. In Mississippi area 100, capital ownership costs are nearly the same across enterprise sizes.

Preharvest costs can be disaggregated into associated cost components to get yet a clearer picture of relative costs between enterprise sizes within the selected cotton producing areas. See Table 84. In Alabama area 600, large and medium enterprises use substantially less fertilizer, herbicide, insecticide and hired management while using substantially more fuel, repairs and labor. Higher variable preharvest machinery costs like fuel, lubrication and repairs are generally related to the use of a smaller and less efficient machines pulled over an acre more times per given operation. In California area 500, large cotton enterprises have substantially lower fuel, lubrication, repair, labor and purchased irrigation water costs relative to very large enterprises. In this area, medium enterprises

Table 83. Preharvest, Harvest and Capital Ownership Costs by Enterprise Size in the Selected Cotton Producing Areas in 1982

State, Area and Enterprise Size	Total Cost		Preharvest		Harvest		Ownership	
	$/acre	%	$/acre	%	$/acre	%	$/acre	%
AL 600								
VL	424	100	245	100	84	100	95	100
L	438	103	240	98	84	100	114	120
M	443	104	235	96	88	105	120	126
CA 500*								
VL	680	100	407	100	165	100	108	100
L	619	91	371	91	155	94	93	86
M	613	90	356	87	151	92	106	98
MS 100								
VL	412	100	223	100	97	100	92	100
L	424	103	239	107	92	95	93	101
M	399	97	214	96	96	99	89	97
TX 200*								
VL	214	100	119	100	44	100	51	100
L	206	96	117	98	44	100	45	88
M	214	100	122	103	44	100	48	94
TX 200								
VL	114	100	62	100	31	100	21	100
L	134	118	71	115	33	106	30	143
M	136	119	78	126	32	103	26	124

*irrigated

Table 84. Preharvest Variable Costs per Acre in Determining Size Economics in the Selected Cotton Producing Areas in 1982.

Item	Enterprise Size	Alabama 600		California 500		Mississippi 100		Texas 200*		Texas 200	
		$/acre	Diff.	$/acre	Diff.	$/acre	Diff.	$/acre	Diff.	$/acre	Diff.
Seed & Application	VL	5	0	8	0	4	0	8	0	7	0
	L	5	0	7	-1	5	1	8	0	8	1
	M	6	1	6	-2	5	1	9	1	8	1
Fertilizer, Lime & Custom Application	VL	77	0	45	0	27	0	5	0	10	0
	L	80	3	47	2	43	16	16	11	3	-7
	M	53	-24	65	20	32	5	10	5	6	-4
Herbicide, Insecticide % Custom Applic.	VL	92	0	26	0	90	0	16	0	4	0
	L	78	-14	34	8	84	-6	9	-7	9	5
	M	88	-4	33	7	84	-6	10	-6	8	4
Fuel, Lubrication, Repairs and Labor	VL	27	0	76	0	44	0	35	0	26	0
	L	46	19	57	-19	38	-6	37	2	36	10
	M	55	28	80	4	47	3	33	-2	39	13
Irrigation	VL	0	0	85	0	6	0	33	0	0	0
	L	0	0	58	-27	10	4	24	-9	0	0
	M	0	0	45	-40	1	-5	34	1	0	0
Other	VL	27	0	88	0	25	0	11	0	7	0
	L	14	-13	89	1	33	8	11	0	7	0
	M	16	-11	48	-40	18	-7	15	4	10	3
General Farm Overhead		17	0	79	0	27	0	11	0	8	0
Total	VL	245	0	407	0	223	0	119	0	62	0
	L	240	-5	371	-36	240	17	116	-3	71	0
	M	235	-10	356	-51	214	-9	122	+3	79	17

* irrigated

have substantially higher fertilizer costs and substantially lower purchased irrigation water and 'other' including lower management and custom tillage costs relative to very large enterprises. The substantially lower purchased water costs for both large and medium enterprises is an important source of pecuniary diseconomies of size in cotton production in California area 500. (See Table 85). In Mississippi area 100 large and medium cotton enterprises have higher fertilizer costs and lower herbicide and insecticide costs relative to very large enterprise. However, there is no clear pattern of preharvest cost advantage related to enterprise size. In Texas area 200 (irrigated) large and medium cotton enterprises have higher fertilizer costs and lower herbicide and insecticide costs. Again, there is no clear pattern of total preharvest cost advantage related to enterprise size. In Texas area 200 (dryland) large and medium enterprises have lower fertilizer costs and high insecticide and herbicide fuel, lubrication, repairs and labor costs relative to very large enterprises.

The use of irrigation water in cotton production is important in California area 500 and Texas area 200 and to a lesser extent in Mississippi area 100. The price of pumped well water is related to the depth of the wells and associated required lift of the water. The cost of pumped water within an area is constant across enterprise size for wells of a given depth. In California area 500, canal water is also available for purchase. The price of canal water is related to the distance of the enterprise from the source of the canal water. As it happens, in the San Joaquin Valley, which is associated with area 500 in California, the large and medium cotton enterprises are in the northern portion of the valley while the very large cotton

Table 85. Irrigation Costs in the Selected Cotton Producing Areas in 1982

State, Area and Enterprise Size	Purchased Water		Pumped Water[1/]		Total Cost Water	
	$/ acre-in.	acre-in.	$/ acre-in.	acre-in.	$/ acre-in.	acre-in.
AL 600						
VL	0	0	0	0	0	0
L	0	0	0	0	0	0
M	0	0	0	0	0	0
CA 500*						
VL	3.18	26.2	4.57	9.2	3.54	35.4
L	2.20	23.9	4.57	5.3	2.63	29.2
M	1.13	24.4	4.57	7.7	1.96	32.0
MS 100*						
VL	0	0	7.61	1.5	7.61	1.5
L	0	0	7.61	2.3	7.61	2.3
M	0	0	7.61	.2	7.61	.2
TX 200*						
VL	0	0	7.49	7.3	7.49	7.3
L	0	0	7.49	5.4	7.49	5.4
M	0	0	7.49	7.5	7.49	7.5
TX 200						
VL	0	0	0	0	0	0
L	0	0	0	0	0	0
M	0	0	0	0	0	0

1/ Includes fule, lubrication, repairs and ownership costs.

*irrigated

enterprises are in the southern portion. The result is pecuniary diseconomies of size in cotton production by as much as \$1.50/acre-inch related to purchased irrigation water resulting from the historical pattern of agricultural development in this area.

Capital ownership costs can also be disaggregated into associated cost components. See Table 86. Capital ownership costs in cotton production are defined as depreciation, taxes, insurance and interest (opportunity cost) on tractors and machinery used in land preparation, cultivation, fertilizer and chemical application, planting, irrigation, harvesting and hauling. In Alabama area 600, large and medium cotton enterprises have higher ownership costs of durables associated with each field operation except harvesting. Harvesting cost/acre is constant across enterprise size for a given size harvester. Relative capital ownership costs are related to the number and size of machines and tractors required to accomplish a particular field operation. Thus large and medium cotton enterprises in Alabama area 600 use some combination of smaller machines, pulled more times over the field for a given operation than is the case for very large enterprises.

In California area 500, large and medium cotton enterprises have lower irrigation and hauling capital ownership costs relative to very large enterprises. The lower irrigation costs relate to the higher ratio of purchased water relative to well pumped water because of the lower cost of purchased water for large and medium enterprise for the reasons explained above.

In Mississippi area 100, large and medium cotton enterprises have higher land preparation ownership costs and lower cultivation ownership costs. This latter point is important in light of the fact

Table 86. Ownership Costs Per Acre in Determining Size Economies in the Selected Cotton Producing Areas in 1982

Item		Alabama 600		California 500		Mississippi 100		Texas 200*		Texas 200	
		$/acre	Diff.	$/acre	Diff.	$/acre	Diff.	$/acre	Diff.	$/acre	Diff.
Land Preparation	VL	13	0	15	0	13	0	10	0	6	0
	L	16	3	13	-2	21	8	9	-1	10	4
	M	18	5	17	2	18	5	6	-4	9	3
Cultivation	VL	4	0	6	0	12	0	2	0	3	0
	L	13	9	4	-2	7	-5	5	3	5	2
	M	12	8	6	0	7	-5	4	2	4	1
Planting, Fertilizer & Chem. Applic.	VL	3	0	2	0	8	0	1	0	1	0
	L	7	4	1	-1	4	-4	1	0	2	1
	M	11	8	3	1	10	2	2	1	2	1
Irrigation	VL	0	0	11	0	5	0	22	0	0	0
	L	0	0	6	-5	8	3	16	-6	0	0
	M	0	0	9	-2	1	-4	22	0	0	0
Harvesting	VL	70	0	60	0	44	0	10	0	7	0
	L	70	0	60	0	44	0	9	-1	9	2
	M	70	0	60	0	44	0	8	-2	6	-1
Hauling	VL	5	0	14	0	10	0	6	0	4	0
	L	8	3	9	-5	9	-1	5	-1	4	0
	M	9	4	11	-3	9	-1	6	0	5	1
Total	VL	95	0	108	0	92	0	51	0	21	0
	L	114	19	93	-15	93	1	45	-6	30	9
	M	120	25	106	-2	89	-3	48	-3	26	5

* irrigated

that large and medium enterprises also reported spending less on herbicides and insecticides. Taken together these facts are consistent with the lower yields on the medium enterprise sizes. Overall, however, ownership costs are nearly constant across enterprise sizes in this area.

In Texas area 200 (irrigated), large and medium cotton enterprises have lower land preparation and harvesting ownership costs and higher cultivation ownership costs. The result is lower overall ownership costs for large and medium enterprises relative to very large enterprises. The higher cultivation ownership costs relate to the additional times over which are used as a substitute for the more costly herbicides. Large and medium enterprise spend substantially less on herbicides and insecticides than is the case for very large enterprises.

In Texas area 200 (dryland), large and medium cotton enterprises have higher land preparation, cultivation and fertilizer and chemical application and planting ownership costs than very large enterprises. Large and medium enterprises in this area use some combination of smaller machines, pulled more times over the field for these field operations for a given horsepower tractor than is the case for very large enterprises.

In summary, size economies exist for Alabama area 600 very large cotton enterprises because these enterprises incur lower machinery and tractor related expenses for a given field operation and still manage to obtain a slightly higher yield. In California area 500, size diseconomies are primarily related to the pecuniary diseconomies of purchased irrigation water for cotton production. In Mississippi area

100, the lack of size economies in cotton production for very large and large enterprises relative to medium enterprises relates to similar preharvest and ownership costs in conjunction with slightly higher yields. In Texas area 200 (irrigated) the relative absence of size economies is related to the combination of size diseconomies in cultivation along with slightly higher yields enjoyed by large and medium enterprises in this area. In Texas area 200 (dryland) size economies for very large enterprises relate to the substantial preharvest and ownership cost advantage associated with lower machinery and tractor related expenses for a given field operation without substantial loss in yield. However, very large dryland cotton producers in this area are exposed to a large amount of risk associated with the variability in rainfall from year to year.

7.2 Comparative Advantage in Cotton Production

In the previous section we focused our attention exclusively on size economies within a production area. In this section we shift our attention to the comparative advantage in cotton production among areas. Production cost data by enterprise size are combined using the static relative Herfindahl index as a weight. To this data is added data on average county level land prices from the 1982 Census of Agriculture (COA). Yield information is changed from COA to the USDA's Statistical Reporting Service (SRS) data on county level yield per planted acre using a five year moving average over the period from 1972 to 1983. The overall objective for including comparative advantage is to provide a context within which to analyze size economies. The secondary objective of this subsection is to determine the source or explain the absence of comparative advantage between the selected production areas.

We begin by comparing the relationship between comparative advantage and size economies in the selected cotton producing areas. See Table 87. In Alabama area 600, the average total cost per bale in producing cotton is higher than in Mississippi area 100. Size economies exist in cotton production in this Alabama area for very large enterprises. The average enterprise size is about 1200 acres and is one of the lowest of the cotton areas studied. This size of enterprise can full utilize 1 or more self-propelled two row pickers. Production concentration, on the other hand, is the highest of the areas studied and production and resources are concentrating at a rate of 9% per year. Since cotton production in this area is at a substantial competitive disadvantage, producers appear to be adopting a strategy of increasing enterprise size as a means of exploiting size economies and increasing their competitiveness.

In California area 500, the average total cost per bale of cotton is higher than in Mississippi area 100. Size economies are minimal. The average cotton enterprise is about 2100 acres in size and is the second most concentrated cotton producing area in the study. This size enterprise can full utilize from one to several self-propelled two-row pickers. Production concentration has increased by about 9% per year. This high positive rate of production concentration suggests that production is becoming concentrated in very large and large enterprise sizes.

In Mississippi area 100, the average total cost per bale of cotton is the lowest of areas studied. Size economies are modest. The

Table 87. The Relationship Between Comparative Advantage and Size Economies in the Selected Cotton Producing Areas in 1982

State and Area	Total Cost[1/]		Size Economics	Relative Size acres	Herfindahl	
	$/bale	%			Static[2/] absolute[3/]	Dynamic[4/] %
AL 600	484	123	VL	1225	187,090-8	36
CA 500*	428	109	none	2088	144,280-8	37
MS 100	393	100	none	1787	72,240-8	23
TX 200*	396	101	none	1224	33,180-8	78
TX 200	409	104	VL	3283	20,980-8	6

*irrigated

[1/] Includes land charge and a 5-year average yield 1979-1983.
[2/] State level measure for the three enterprise size categories.
[3/] Scientific notation.
[4/] Change in the state level measure between 1978 and 1982.

average cotton enterprise in this area is about 1800 acres. This size enterprise can utilize the capacity of 1 or more self-propelled 2-row harvesters. Production concentration is greater than in Texas area 200 (dryland or irrigated) and less than Alabama area 600 or California area 500. The change in production concentration is about 6% per year. This is the next to the slowest rate of change in cotton production concentration of the areas studied. Since cotton production in this area is already the most competitive of any, of the selected areas, producers have adopted a strategy of moderate enterprise expansion as a strategy to increase total revenue rather than to increase comparative advantage.

In Texas area 200 (irrigated) the average total cost per bale of cotton is higher than in Mississippi area 100. Size economics in Texas area 200 (irrigated) do not exist for very large enterprise sizes under the 1982 enterprise configuration. The average enterprise size is about 1200 acres per enterprise. This enterprise size can utilize the capacity of 1 or more cotton strippers. Production concentration in 1982 was among the lowest of the several areas. The change in production concentration, however, is about 20% per year which is the highest. This very high positive rate of resource concentration in the absence of size economies for very large enterprises suggests that production is becoming concentrated in the very large, large and medium relative to the small size class.

In Texas area 200 (dryland) the average total cost per bale of cotton is higher than in Mississippi area 100. Size economies do exist for very large enterprises. The average cotton enterprise size is about 3300 acres and the largest average enterprise size of the areas studied. The production concentration is the lowest of the cotton producing areas studied. The change in production concentration is about 2% per year. This is very low relative to the other cotton producing areas and in particular when compared to irrigated cotton. Yields in this area are subject to wide variation due to weather in the absence of irrigation water. Therefore, producers seem to have adopted a strategy of non-expansion in the face of rather fully exploited size economies. There appears to be a trend away from dryland cotton in favor of irrigated cotton in Texas area 200. The future success of this strategy depends in part on relative yields, water availability and land prices compared with other cotton producing areas.

Let us turn our attention now to the objective of determining the source or explaining the absence of comparative advantage between the selected cotton producing areas. The comparative advantage for a production area is based on the total production costs per bale for a representative enterprise of the 40th through 90th deciles of enterprises in a given area. The production costs and yields for these representative enterprises for the selected cotton producing areas are presented in Table 88.

The results indicate that the comparative advantage in cotton production of the selected areas is in Mississippi area 100. On the basis of yield, California area 500 has the highest five year average yield at about 2 bales per acre while Texas area 200 (dryland) has the lowest five-year average yield at less than one half bale per acre. Similarly, California area 500 has the highest total cost per acre (including a 10% land charge) while Texas area 200 (dryland) has the lowest total cost.

To get a clearer picture of the trends in relative yield, let us review the SRS data on yield per planted acre from 1972 to 1983 in the selected cotton producing areas. See Table 89 and Figure 12. In particular, we are interested in the trend of the change in relative yields between the selected areas using yield in Mississippi area 100 as the basis for comparison. In Alabama area 600, the trend in cotton yield has increased at a rate of about 5% per year from 1974 to 1981. This rate of growth in cotton yield in Alabama area 600 resulted in an increase in relative yield compared to Mississippi area 100. In

California area 500, cotton yields have increased very slightly. This modest (.4%) rate of growth in cotton yield in California area 500 resulted in a decrease in relative yield compared to Mississippi area 100. In Mississippi area 100 the absolute yield has increased from an average of 1.04 bales/acre in 1974 to an average of 1.37 bales/acre in 1981 or about 5% per year. In Texas area 200, cotton yields have decreased for both irrigated and dryland cotton. This decline in cotton yields in Texas area 200 resulted in a major decrease in relative yield compared to Mississippi area 100 for irrigated and dryland cotton.

Let us compare cotton yields to rates of application of seed of nitrogen fertilizer by production area again using Mississippi area 100 as the basis for comparison. See Table 90. In Alabama area 600, producers use more seed, phosphate and potash per bale of cotton and realize 18% lower yield than in Mississippi area 100. In California area 500, producers use less seed, nitrogen, and potash and realize a 53% higher yield than in Mississippi area 100. In Mississippi area 100, cotton producers use 11 lbs of seed, 79 lbs of nitrogen, 7 lbs of phosphate and 18 lbs. of potash on average to produce one bale (480 lbs.) of cotton lint while producing about 1.4 bales per acre. In Texas area 200, irrigated cotton producers use more seed, and phosphate and realize a 51% lower yield than in Mississippi area 100. Finally, in Texas area 200, dryland cotton producers use more seed and phosphate per bale of cotton and realize a 67% lower yield than in the case in Mississippi area 100. These results suggest that California area 500 has an array of initial resource endowments so that on

Table 88. Comparative Advantage in Cotton Production in the Selected Areas in 1982

State and Area	Total Cost 1/		Yield 2/		Total Cost 1/	
	$/bale	%	Bales/acre	%	$/acre	%
AL 600	484	123	1.13	82	547	102
CA 500*	428	109	2.10	153	898	166
MS 100	393	100	1.37	100	538	100
TX 200*	396	101	.67	49	265	49
TX 200	409	104	.45	33	184	34

*irrigated

1/Includes land charge based on 1982 land values.
2/Five year average yield centered on 1981.

Table 89. A Summary of Five Year Average Cotton Yields in the Selected Producing Areas

State and Area	1981 1/ Bales /planted acre	1974-1981 Bales		1978 2/ /planted acre	1978-1981 Bales		1974 3/ /planted acre	1974-1978 Bales	
		%	%/yr		%	%/yr		%	%/yr
AL 600	1.13	82	5.2	.84	78	11.5	.82	80	0.4
CA 500*	2.10	153	0.4	1.88	174	3.9	2.04	196	-2.6
MS 100	1.37	100	4.5	1.08	100	9.0	1.04	100	1.0
TX 200*	.67	49	-2.3	.77	71	-4.3	.80	77	-0.9
TX 200	.45	33	-3.5	.46	43	-0.7	.60	58	-5.8

1/ Five year average from 1979 to 1983.
2/ Five year average from 1976 to 1980.
3/ Five year average from 1972 to 1976.

*irrigated

FIGURE 12. FIVE-YEAR AVERAGE TREND IN COTTON YIELD
IN THE SELECTD AREAS OF ALABAMA,
CALIFORNIA, MISSISSIPPI AND TEXAS(DRY,IRR)

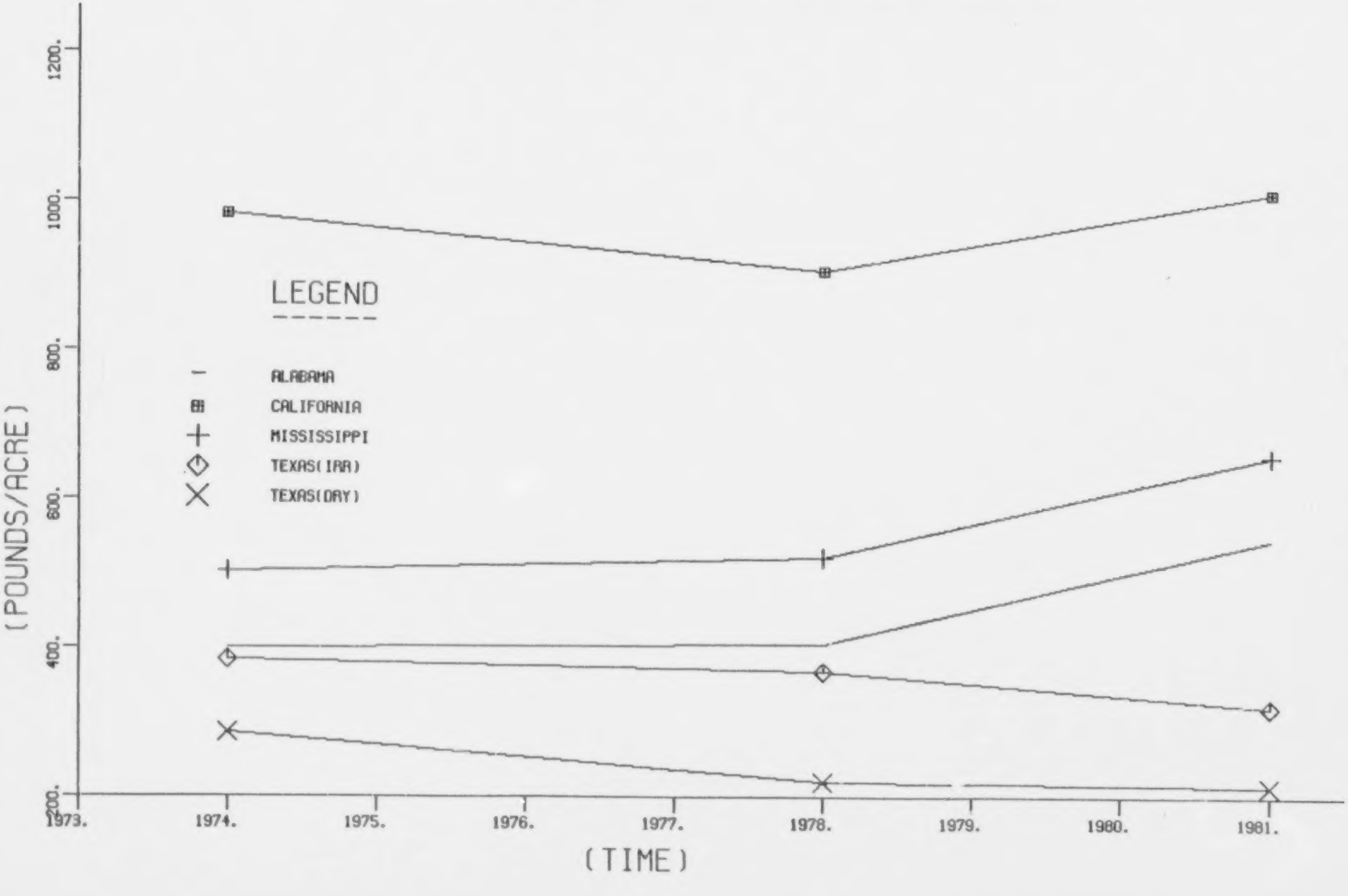


Table 90. Application Rates of Seed and Fertilizer in the Selected Cotton Producing Areas in 1982

	AL 600		CA 500*		MS 100		TX 200*		TX 200	
Input	lbs/ bale	%	lbs/ bale	%	lbs/ bale	%	lbs/ bale	%	lbs/ bale	%
Seed	15.4	140	8.6	78	11.0	100	36.6	333	48.2	438
Nitrogen	75	95	55	70	79	100	31	39	33	42
Phosphate	59	843	11	157	7	100	30	429	24	343
Potash	59	328	0	0	18	100	3	17	7	39

*irrigated

average this area is better suited to cotton production that are the other areas.

Production costs per bale can be disaggregated into associated cost categories to provide greater insight into the source of comparative advantage. Table 91 provides a summary of preharvest, harvest, ownership and land costs per bale for the selected cotton producing areas. Preharvest costs are highest in Alabama area 600 and lowest in Texas area 200 (dryland). Variable harvest costs are highest in California area and the lowest in Texas area 200 (irrigated). Ownership costs are the highest in Alabama area 600 and the lowest in California area 500. Finally, land charges are the highest in Texas area 200 (dryland) and the lowest in Texas area 200 (irrigated) assuming a 10% return on 1982 land prices.

The land charge is the most costly single item in the production of cotton and the second most costly category comprising on average bout 25% of the cost of inputs given a 10% return to land. Table 92 and Figure 13 summarize the land values in the selected cotton pro-

Table 91. Production Costs Per Bale in the Selected Cotton Producing Areas in 1982

State and Area	Total[1]		Preharvest		Harvest		Ownership		Land charge[2]	
	$/ bale	%	$/ bale	%	$/ bale	%	$/ bale	%	$/bale	%
AL 600	484	123	213	128	75	109	95	142	101	112
CA 500*	428	109	185	111	76	110	48	72	119	132
MS 100	393	100	166	100	70	100	67	100	90	100
TX 200*	396	101	178	107	66	96	72	107	80	89
TX 200	409	104	153	92	71	103	58	87	127	141

[1] Includes 10% land charge on 1982 land values.

[2] Adjusted for additional land required for skip row cultivation.
These are 1.09, AL 600 dryland
1.06, CA 500 irrigated
1.12, MS 100 dryland & irrigated
1.05, TX 200 irrigated
1.11, TX 200 dryland

*irrigated

ducing areas based on county level nominal land values reported in the 1982, 1978 and 1974 editions of the Census of Agriculture. As with yield, the item of interest is the trend in the relative land values between the cotton producing areas. Again the land values in Mississippi area 100 are used as the basis for comparison. In Alabama area 600, nominal land values increased about 14% per year from 1974 to 1982. This rate of appreciated in land values in resulted in a decrease in the relative land values compared to Mississippi area 100. In California area 500, nominal land values increased about 28% per year. This rate of appreciation in land values in California area 500

Table 92. Land Values Per Acre in the Selected Cotton Producing Areas in 1974, 1978 and 1982

State and Area	1982		1982-74	1978		1982-78	1974		1978-74
	$/ acre	%	% /yr	%/ acre	%	% /yr	$/ acre	%	% /yr
AL 600	1043	95	14.2	805	101	7.4	488	114	16.2
CA 500*	2348	214	28.4	1372	172	17.8	718	168	22.8
MS 100	1097	100	19.6	797	100	9.4	427	100	21.7
TX 200*	513	47	11.3	402	50	6.9	270	63	12.2
TX 200	513	47	11.3	402	50	6.9	270	63	12.2

*irrigated

resulted in an increase in relative land values compared to Mississippi area 100. In Mississippi area 100, nominal land values appreciated about 20% per year from 1974 to 1982. In Texas area 200 (irrigated and dryland), nominal land values increased about 11% per year. This rate of appreciation in land values in Texas area 200 resulted in a decrease in relative land values compared to Mississippi area 100. Even declining land prices can continue these trends as long as similar proportions are maintained. It is unlikely that these trends will be offset by lower costs in some other input categories.

The combination of relative cotton yield and land price trends provides some insight regarding the change in comparative advantage in the future if these trends continue, other things being equal. In Mississippi area 100, cotton yields have increased at a rate of about 5% per year while land prices have increased at about 20% per year.

In comparison, in Alabama area 600, relative cotton yields have increased on average while relative land prices have decreased compared to Mississippi area 100 over the period from 1974 to 1982. If these trends continue, then the competitive position of cotton production in Alabama area 600 should improve slightly relative to Mississippi area 100 though it probably will continue to be a marginal cotton producing area. In California area 500, relative cotton yields have decreased while relative land prices have increased compared to Mississippi area 100. If these trends continue, then the competitive position of cotton production in California area 500 will decrease relative to Mississippi area 100. In Texas area 200, relative cotton yields have decreased for irrigated and dryland cotton compared to Mississippi area 100. Meanwhile in Texas area 200 during this same time period, relative land prices have decreased compared to Mississippi area 100. If these trends continue, then the competitive position of cotton production in Texas area 200 will probably not improve relative to Mississippi area 100.

Preharvest cost is the most costly category in cotton production in the selected areas. Preharvest costs per bale are disaggregated in Table 93. The preharvest items include seed; fertilizer and lime; herbicides and insecticides; fuel, lubrication, repairs and labor; irrigation, general farm overload and "other." In Alabama area 600, expenditures on phosphate, potash, lime and pesticides are substantially higher than in Mississippi area 100. In California area 500, expenditures on herbicides and insecticides are substantially lower while expenditures on irrigation water, "other" labor and general farm overhead are substantially higher than in Mississippi area 100. In

FIGURE 13. QUADRENNIAL TREND IN LAND PRICES IN THE COTTON PRODUCING AREAS OF ALABAMA, CALIFORNIA, MISSISSIPPI AND TEXAS(DRY, IRR)

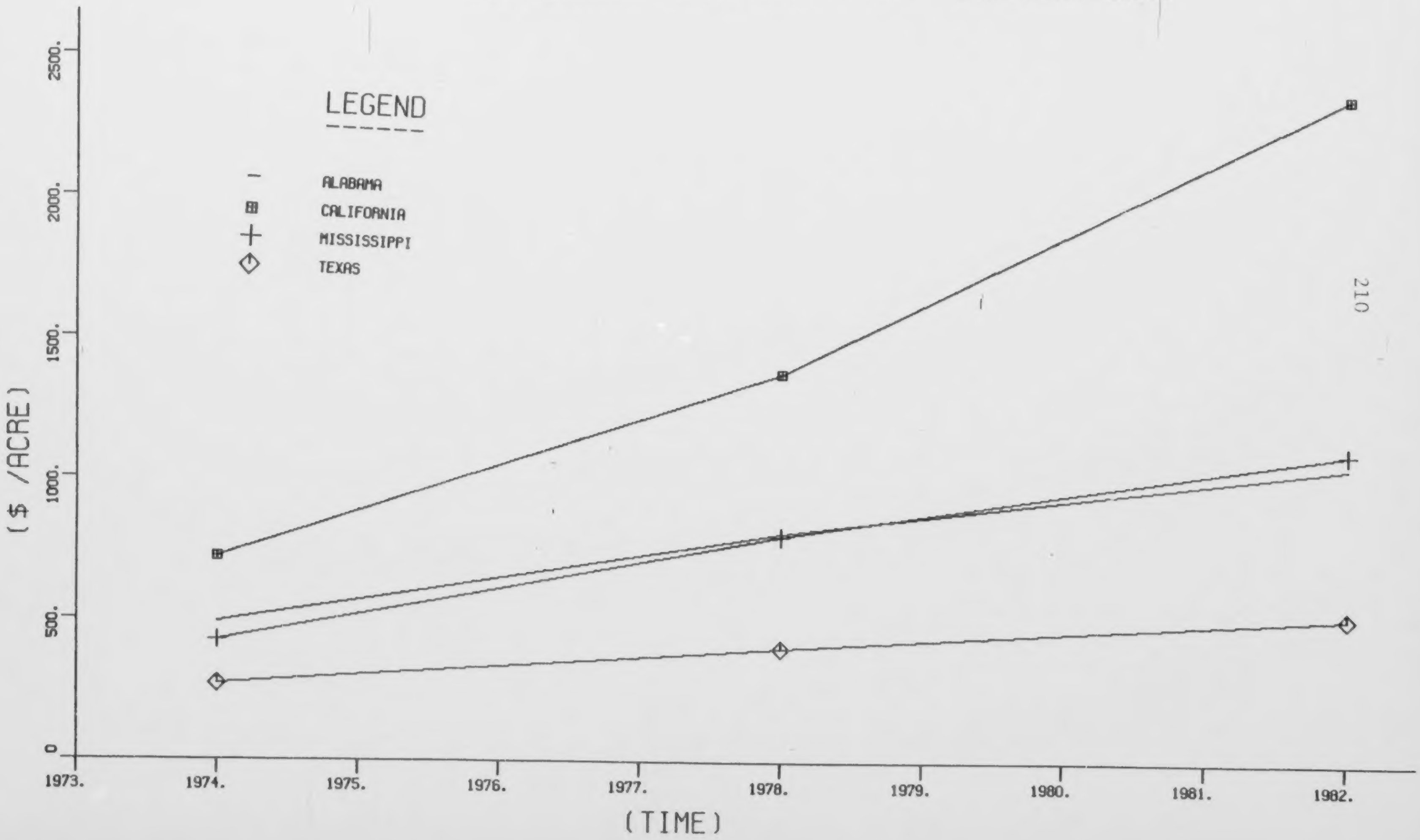


Table 93. Preharvest Costs Per Bale in Determining Comparative Advantage in the Selected Cotton Producing Areas in 1982

Preharvest Item	AL 600		CA 500*		MS 100		TX 200*		TX 200	
	$/bale	Diff.	$/bale	Diff.	$/bale	Diff.	$/bale	Diff.	$/bale	Diff.
Seed	5	1	3	-1	4	0	12	8	15	11
Fertilizer & Lime	63	38	22	-3	25	0	15	-10	16	-9
Pesticides	77	14	14	-49	63	0	19	-44	16	-47
Fuel, Repair, Labor	35	4	32	1	31	0	52	21	73	42
Irrigation	0	-5	34	29	5	0	45	40	0	-5
Other	18	-1	42	23	19	0	18	-1	15	-4
General Farm Overhead	15	-4	38	19	19	0	17	-2	18	-1
Total	213	47	185	19	166	0	178	12	153	-13

*irrigated

Mississippi area 100, preharvest expenditures are greatest for herbicides and insecticides; fuel, labor and repairs; and fertilizer and lime, in that order. In Texas area 200 (irrigated), expenditures on fertilizer and lime and on herbicide and insecticide are substantially lower while expenditures on fuel, machinery labor and irrigation water are substantially higher than in Mississippi area 100. In Texas area 200 (dryland) expenditures on herbicides and insecticides are substantially lower while expenditures on fuel, repairs, labor and seed are substantially higher than in Mississippi area 100.

Capital ownership cost is the cost category with the least variability across production areas. See Table 94. Ownership cost items include depreciation, taxes, insurance and interest (opportunity cost) associated with durables used in land preparation, cultivation, fertilizer and chemical application, planting, irrigation, harvesting and hauling. In Alabama area 600, harvesting ownership costs are substantially above those in Mississippi area 100. The combination of lower yields and more times over the field are the cause for higher harvesting costs per bale. On average cotton producers pick their field 2.0 times in Alabama area 600 and 1.6 times Mississippi area 100. In California area 500, ownership costs per bale in each category are slightly lower than in Mississippi area 100. In Mississippi area 100, capital ownership costs are greatest for durables used for harvesting and land preparations in that order. In Texas area 200 (irrigated), irrigation ownership cost are substantially higher and harvesting ownership costs are substantially lower than in Mississippi area 100. The difference in irrigation ownership costs is related to the percentage of enterprises which use pumped water as part of their

Table 94. Capital Ownership Costs Per Bale in Determining Comparative Advantage in the Selected Cotton Producing Areas in 1982

Field	AL 600		CA 500*		MS 100		TX 200*		TX 200	
Operation	$/bale	Diff.	$/bale	Diff.	$/bale	Diff.	$/bale	Diff.	$/bale	Diff.
Land Preparation	13	1	7	-5	12	0	13	1	18	6
Cultivation	8	1	2	-5	7	0	5	-2	9	2
Fertilizer, Chem.,and Planting	6	1	1	-4	5	0	2	-3	4	-1
Irrigation	0	-4	4	0	4	0	30	26	0	-4
Harvesting	62	30	29	-3	32	0	13	-19	18	-14
Hauling	6	-1	5	-2	7	0	9	2	9	2
Total	95	28	48	-19	67	0	72	5	58	-9

*irrigated

production practice which is 100% for Texas 200 (irrigated) and only about 10% in Mississippi area 100. The difference in harvesting ownership costs relates to the use of less costly once over cotton strippers used in Texas area 200 (irrigated) instead of cotton pickers which go over the field 1.6 times on average in Mississippi area 100. In Texas area 200 (dryland) harvesting ownership costs are also substantially lower than in Mississippi area 100. The reason is the same as that for lower harvesting ownership cost in Texas area 200 (irrigated).

7.3 Summary

In summary, in Alabama area 600, the comparative disadvantage in cotton production is due to low yields, high fertilizer, lime, and insecticide and harvesting costs. If the past trends in relative yield and land prices continue, Alabama area 600 can slightly improve its competitive position. Size economies for very large enterprises have not been fully exploited in this area. However, it is likely that Alabama area 600 will continue to be a marginal cotton producing area. The Herfindahl indices imply that producers are concentrating resources in the very large enterprise size and they will probably continue to do so.

In California area 500, the comparative disadvantage in cotton production is due to high irrigation water costs including "other" labor costs. If the past trends in yield and land prices continue, California area 600 will lose competitive position relative to Mississippi area 100. Economies of size exist in California area 600 and can be exploited to help offset any decreasing comparative advantage. The Herfindahl indices suggest that productive resources are concentrated in the very large and large enterprise sizes.

In Mississippi area 100, the comparative advantage in cotton production is due to the level of yields relative to the cost of fertilizer, seed and chemical inputs. If the past trends in yield and land prices continue, Mississippi area 100 can maintain its competitive position in the future as well, other things being equal. Size economies are fully utilized in this area however. The Herfindahl indices show that resources are concentrated in the very large and large enterprise sizes.

In Texas area 200 (irrigated), the competitive position in cotton production is less than in Mississippi area 100. This area however has an initial resource endowment including a climate that minimizes problems with weeds and insects. If past trends in relative yield and land prices continue, Texas area 200 (irrigated) will probably not improve their competitive position. Producers in this area seem to be quickly adopting irrigation as a means of decreasing variability as well as increasing the average yield. However irrigation water is limited and size economies do not appear to exist for very large irrigated cotton enterprises and therefore do not exist as an additional means of improving comparative advantage. The Herfindahl indices show that resources are concentrated in the very large enterprise size and each size category shows substantial resource concentration since 1978.

In Texas area 200 (dryland) the competitive position in cotton production is less than in Mississippi area 100. If past trends in yield and land prices continue, Texas area 200 (dryland) will not improve its comparative advantage. Size economies appear to exist for very large enterprises in this area. However the variability in cotton yields may well preclude a proliferation of very large cotton producers, since the capital assets of these producers would be exposed to a large element of risk. The Herfindahl indices suggest resource concentration in the very large and large enterprise sizes and that this concentration is very stable given the current enterprise configuration.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

We began this paper with a statement by Willard Cochrane regarding our almost total ignorance about the shape of the long-run average cost curve at very large volumes of output. Cochrane's interest in the shape of the long-run average cost curve relates to his concern over resource concentration and the structure of farming. This work on size economies provides a point of reference from which to hypothesize about resource concentration, size economies and comparative advantage. The following sections presents a summary of the data associated with internal economies of size and comparative advantage for each of the commodities studied including corn, soybeans, wheat, rice and cotton.

Internal size economies are summarized using a weighted average of measures outlined in the methodology section. These measures include production cost, utilization of harvesting machinery and the relative Herfindahl indices (both static and dynamic). In addition a structural elasticity measure of internal size economies is reported. We use Stigler's measure of arc elasticity applied to the percentage increase in enterprise size in acres relative to a 1% decrease in production costs. In particular, we are estimating the structural arc elasticity associated with an increase in enterprise size from medium (40th through 60th deciles) to very large (90th decile) for each commodity. Stigler's arc elasticity equation is defined as:

$$(1) \quad E_{MVL} = \frac{Q_{VL} - Q_M}{Q_{VL} + Q_M} \quad \frac{P_{VL} - P_M}{P_{VL} + P_M} \qquad (1960, \text{ p. } 35)$$

where E_{MVL} is the structural elasticity associated with an increase in enterprise size from medium (M) to very large (VL)

Q is the enterprise size measured in acres

P is the average production cost associated with an enterprise size measured in dollars per unit of output.

The structural elasticity implies that producers may make relatively marginal adjustments in enterprise size and receive a marginal reduction in costs. This continuity assumption may not be true for individual producers since the purchase of more expensive and efficient manufactured durables may require an associated lumpy purchase of complementary resources including land. However in the aggregate as producers expand their enterprise size, the structural elasticity measure provides insight into the efficiency-resource concentration trade-off being made on average within the industry.

A summary of these indices is presented in Tables 95 and 96 by commodity for each area and as a weighted average across areas. Table 97 presents the results of the scoring procedure. This table still includes only four measures of size economies. The static and dynamic relative Herfindahl indices have been combined and the structural elasticity has been added.

Table 95. A Summary of the Measures of Internal Economies of Size in the Selected Corn, Soybean and Wheat Producing Areas in 1983

Commodity State & Area	Economies of Size	Structural Elasticity1/ (%)	Enterprise Size (acres)		Enterprise Cost ($/unit)		Harvester Utilization (units)		Relative Herfindahl Indices			
									Static (%)		Dynamic (%)	
			M	VL	M	VL	M	VL	M	VL	M	VL
Corn												
IL 300	VL	-7	246	1113	119	100	.5	2.4	43	100	-15	35
IN 101	VL	-22	271	903	105	100	.6	2.0	79	100	11	32
IO 201	VL	-22	170	576	105	100	.4	1.3	85	100	-11	48
NE 400*	VL	-12	266	1715	113	100	.6	3.7	43	100	-2	42
Overall	Increasing	-15	234	1003	111	100	.5	2.2	62	100	-6	39
Soybeans												
IL 300	None	-44	270	684	102	100	.7	1.8	80	100	-4	65
IO 201	VL	-14	210	707	108	100	.5	1.9	198	100	-5	38
MS 100	None	45	795	1262	99	100	1.0	1.6	24	100	11	9
OH 101	None	8	244	897	86	100	.6	2.3	73	100	-3	71
Overall	Constant	-179	302	790	101	100	.7	1.9	107	100	-3	53
Wheat												
KS 100	VL	-8	774	3909	118	100	1.5	7.7	75	100	-7	17
MT 200	VL	-12	421	1577	110	100	.8	3.1	6	100	-31	20
ND 200	None	-38	338	1283	103	100	.7	2.5	36	100	-8	47
WA 400	None	6	753	2388	85	100	1.5	4.8	31	100	-2	3
Overall	Constant	-36	647	2661	103	100	1.3	5.3	46	100	-8	18

1/ Arc elasticity is equal to the percentage change in enterprise size in acres for a 1% change in production costs relative to the medium and very large enterprise size range.

* irrigated

Table 96. A Summary of the Measures of Internal Economies of Size in the Selected Rice and Cotton Producing Areas in 1979 and 1982 Respectively

Commodity State & Area	Economics of Size	Structural Elasticity 1/ (%)	Enterprise Size (acres)		Enterprise Cost ($/unit)		Harvester Utilization (units)		Relative Herfindahl Indices			
									Static (%)		Dynamic (%)	
			M	VL	M	VL	M	VL	M	VL	M	VL
Rice												
CA 400	None	40	850	3575	97	100	1.8	7.7	25	100	-19	-4
TX 1001	None	33	691	2068	97	100	1.5	4.4	61	100	20	28
DLT 100-300	None	14	509	1904	92	100	1.0	3.8	58	100	11	-35
AK 200	None	30	377	1619	96	100	.8	3.3	67	100	-7	21
Overall	Decreasing	27	625	2397	96	100	1.3	5.0	51	100	-2	4
Cotton												
AL 600	VL	-14	568	1842	108	100	1.5	4.7	64	100	8	63
CA 500	None	64	614	2833	98	100	1.3	6.1	6	100	9	39
MS 100	None	infinite	754	2868	100	100	2.0	7.6	48	100	21	24
TX 200*	None	118	436	1707	99	100	.8	3.2	35	100	80	77
TX 200	VL	-9	972	5920	117	100	2.0	12.4	51	100	5	6
Overall	Constant	-77	653	3040	102	100	1.4	6.6	27	100	24	40

1/ Arc elasticity equals the percentage change in enterprise size in acres for a 1% change in production costs relative to the medium and very large enterprise size range.

Table 97. Scoring Table Used to Determine Overall Size Economies in Corn, Soybean, Wheat, Rice and Cotton Areas on Average Between Medium and Very Large Enterprises

Commodity & Enterprise Size	Cost of Production	Full Harvester Utilization	Relative Herfindahl Indices	Structural Elasticity	Total
Corn					
VL	+	+	+	+	4
M	-	-	-	-	0
Soybeans					
VL	-	+	+	-	2
M	-	-	-	-	0
Wheat					
VL	-	+	+	+	3
M	-	+	-	-	1
Rice					
VL	-	+	-	-	1
M	+	+	-	+	3
Cotton					
VL	-	+	-	-	1
M	-	+	-	-	1

8.1 Corn

In corn production, very large enterprises of about 1000 acres have an 11% cost advantage relative to 250 acre medium-size enterprises. See Table 95. The medium and very large corn enterprises utilize approximately .5 and 2 six-row self-propelled harvesters respectively. The change in relative production and resource concentration between 1978 and 1982 is positive for very large corn enterprises and increasing at a rate of about 10% a year. The structural elasticity measure is -15. This indicates that each 15% increase in enterprise acreage (between the 250 and 1000 acre range) results in a 1% decrease in corn production costs. The scoring results are 4 - 0 for very large and medium enterprises respectively. There is strong evidence to argue for the existence of increasing returns to size in corn production across the selected producing areas.

In general, the sources of size economies among the selected corn producing areas are as follows. Corn yields are from 3 to 10% higher on very large enterprise relative to medium size enterprises. Very large corn enterprises have lower expenditures on fertilizer, fuel, lubrication, repairs and custom harvesting relative to medium size enterprises. Finally very large corn enterprises consistently use some combination of fewer and/or more efficient machines and tractors which go over the field fewer times.

Iowa area 201 has a comparative advantage in corn production of the areas studied. See Table 98. Iowa area 201 maintains its comparative advantage regardless of whether the return to land is assumed to be 10% or 5% of its 1982 value.

Table 98. A Summary of the Measures of Inter-Regional Comparative Advantage Among the Selected Corn, Soybean and Wheat Producing Areas in 1983

Commodity State & Area	Returns to Size	Comparative Advantage A[1] (%)	Comparative Advantage B[2]	Enterprise Size (acres)	Absolute Herfindahl Indices Static (%)	Absolute Herfindahl Indices Dynamic (%)
Corn						
IL 300	VL	114	116	653	3480-8	14
IN 101	VL	110	114	586	5700-8	22
IO 201	VL	100	100	335	1790-8	13
NE 400*	VL	108	129	1095	10430-8	20
Total	Increasing	109	113	610	4397-8	16
Soybeans						
IL 300	None	103	102	464	2700-8	17
IO 201	VL	100	100	362	2200-8	10
MS 100	None	124	138	1126	27330-8	9
OH 101	None	105	109	570	5670-8	21
Total	Constant	105	106	521	5582-8	15
Wheat						
KS 100	VL	100	100	2152	3990-8	5
MT 200	VL	103	112	1352	21190-8	9
ND 200	None	109	133	893	6330-8	21
WA 400	None	100	104	1613	29420-8	2
Total	Constant	102	109	1647	14719-8	8

1/ Assumes a 10% rate of return on 1982 land values.

2/ Assumes a 5% rate of return on 1982 land values

* irrigated

Iowa area 201 has the smallest average corn enterprise size, the lowest level of resource concentration and the lowest percentage change in resource concentration of the selected corn producing areas studied. The trends in relative yield and land values indicate that the comparative advantage in corn production in Iowa area 201 will continue in the future other things being equal. There are also size economies which can be exploited. Therefore, the data suggests that corn producers in Iowa area 201 (and the other selected areas) are not operating at the least cost point on their production frontier. We can conclude that the quality of initial resource endowment in Iowa area 201 has provided producers with the ability to remain highly competitive in corn production without fully exploiting size economies.

The comparative disadvantage for Nebraska area 400 increases from 8% to 29% (relative to Iowa area 201) when return to land is reduced from 10% to 5%. This change results in Nebraska area 400 becoming a very marginal corn producing area. This is because Nebraska area 400's competitive position is largely associated with inexpensive land relative to other areas. A lower rate of return to land effectively discounts the source of relative advantage in corn production in this area.

8.2 Soybeans

In soybean production, very large enterprises of about 800 acres acres have a very small cost advantage relative to 300 acre medium size enterprises. The medium and very large soybean enterprises utilize approximately .75 and 2 six-row self-propelled harvesters respectively. The change in relative production and resource concentration is positive for very large enterprises and increasing at a rate of about 13% per year. The structural elasticity is -179. This indicates a flat cost curve in which, for example, a 179% increase (from 300 to 500 acres) in soybean enterprise acreage results in only a 1% decrease in production cost. The scoring results are 2 - 0 for very large and medium enterprises respectively. Thus there is evidence to argue for the existence of relatively constant returns to size in soybean production across the selected producing areas.

In general, the absence of size economies among the selected soybean areas is the result of the following. Soybean yields are only from 1 to 6% higher on very large enterprises relative to medium size enterprises. Very large enterprises have higher expenditures on fertilizer, herbicides and insecticides in proportion to yield. Finally very large enterprises use larger machinery and tractor inputs particularly in land preparation, the cost of which just offset the increase in output. Iowa area 201 is an exception in that internal size economies exist which is not the case in the other selected soybean producing areas. In fact some pecuniary economies exist in Iowa 201 relative to the hiring of custom harvesting by very large enterprises.

Iowa area 201 has a comparative advantage in soybean production among the selected producing areas. Iowa area 201 maintains its comparative advantage regardless of whether the return to land is assumed to be 5 or 10% of its 1982 value. This area has the smallest average soybean enterprise size, the lower level of resource concentration and one of the lowest percentage changes in resource concentration of the selected producing areas. However, the trends in relative yield and land prices indicate that the comparative advantage of Iowa area 201 in soybean production could decrease in the future particularly in relation to Illinois area 300. Iowa area 201 is unique among the soybean areas studied in that it has increasing returns to size which can be further exploited. The data suggests that soybean producers in Iowa area 201 are not operating at the least cost point on their production frontier. We conclude that the quality of the initial resource endowment in Iowa area 201 has provided producers with the ability to remain highly competitive in soybean production without the need to fully exploit size economies.

In Mississippi area 100, the comparative disadvantage in soybean production increases from 24 to 38% relative to Iowa area 201 associated with a 10 and 5% return to land respectively. This change results in Mississippi area 100 becoming an even more marginal soybean producing area. This is because Mississippi area 100's competitive position is associated with less expensive land relative to other areas. A lower rate of return to land effectively discounts the source of comparative advantage in soybean production in this area.

8.3 Wheat

In wheat production, very large enterprises of about 2600 acres have a 3% cost advantage relative to 640 acre medium size enterprises on average. The medium and very large wheat enterprises utilize approximately 1 and 5, 20-feet-wide, self-propelled harvesters respectively. The change in relative production and resource concentration is positive for very large enterprises and increases at a rate of about 5% per year. The structural elasticity is -36. This indicates that each 36% increase in an average wheat enterprise acreage (between) the 640 and 2600 acre range) results in a 1% decrease in per unit production costs. The scoring results are 3 - 1 for very large and medium enterprises respectively. This evidence suggests that any existence of constant returns to size in wheat production across the selected producing areas is rather insignificant.

In general, the absence of size economies in wheat production is the result of statistical averaging. Only North Dakota area 200 exhibits constant returns to size in wheat production. Kansas area 100 and Montana area 200 both have increasing returns to size while Washington area 400 shows decreasing returns to size. In Kansas area 100 pecuniary internal economies associated with custom harvesting is an important source of size economies for very large wheat enterprises. In Montana area 200, size economies for very large wheat enterprises are the result of the combination of slightly higher yield and pecuniary size economies associated with custom harvesting. In North Dakota area 200 the lack of economies of size for very large wheat enterprises is the result of slightly higher yields which are offset by higher harvesting costs relative to medium size enterprises. In Washington area 400, size economies do not exist for very large wheat enterprises relative to medium enterprises because of lower yields and slightly higher capital ownership and harvesting costs.[1]

Kansas area 100 has a comparative advantage in wheat production among the selected areas. Kansas area 100 maintains its comparative advantage regardless of whether the return to land is assumed to be 5 or 10% of its 1982 value. This area has the largest average enterprise size, the lowest resource concentration and one of the lowest percentage changes in resource concentration of the selected wheat producing areas studied. The trends in relative wheat yield and land prices indicate that the comparative advantage of this area could decrease slightly in the future. Kansas area 100 has substantial size economies which can be exploited. The data suggests that wheat producers in Kansas area 100 are not operating at the least cost point on their production frontier. We conclude that the quality of the initial resource endowment in Kansas area 100 provide producers with the ability to remain highly competitive without the need to fully exploit size economies.

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[1] Yield diseconomies in eastern Washington relate to the heterogeneity of rainfall (1 inch additional per 10 miles moving eastward from the Cascade mountains) and the associated relationship between higher rainfall and smaller enterprise size according to L. Blakeslee, Washington State University Agricultural Economist.

In North Dakota area 200, the comparative disadvantage in wheat production increases from 9 to 35% relative to Kansas area 100 when land returns are reduced from 10% to 5%. This results in North Dakota area 100 becoming a marginal wheat producing area as land changes decrease. This is because North Dakota's comparative advantage is associated with less expensive land relative to other areas. A lower rate of return effectively discounts the source of comparative advantage in wheat production in this area.

8.4 Rice

In rice production, very large enterprises of about 2400 acres have a 4% cost disadvantage relative to 600 acre medium size enterprises. See Table 96. The medium size and very large rice enterprises utilize 1 and 5, 16-feet-wide self-propelled harvesters respectively. This change in relative production and resource concentration is positive for very large enterprises but increases at a slow rate (1% per year). The structural elasticity is 27. This indicates that each 27% decrease in the average acreage for a rice enterprise (between 600 and 2400 acres) results in a 1% decrease in production costs. The scoring results are 1-3 for very large and medium enterprises respectively. This provides evidence to argue for the existence of decreasing returns to size in rice production across the selected producing areas.

In general, the presence of internal diseconomies of size among the selected rice producing areas is a result of the following. Rice yields are from about 0 to 10% lower on very large enterprises relative to medium size enterprises. Uneven water distribution can result in lower yields. This is typically a function of the result of inadequate land leveling. But, the data indicate that the extent of land leveling is approximately 100% across all enterprise sizes. Therefore yield diseconomies probably relate mainly to the timeliness of water, fertilizer, herbicide, insecticide and fungicide application. Rice producers on medium enterprises are better able to manage these applications than those on very large enterprises. Finally in Texas area 1001, there are pecuniary diseconomies associated with purchased canal water used for irrigation.

California area 400 has a comparative advantage in rice production among the selected rice producing areas. See Table 99. California area 400 maintains its comparative advantage regardless of whether the return to land is assumed to be 5 or 10% of its 1982 value. California area 400 has the largest average rice enterprise size. This area has the second highest level of production or resource

Table 99. A Summary of the Measures of Inter-Regional Comparative Advantage Among the Selected Rice and Cotton Producing Areas in 1979 and 1982 respectively

Commodity State & Area	Returns to Size	Comparative Advantage A[1] (%)	Comparative Advantage B[2]	Enterprise Size (acres)	Absolute Herfindahl Indices	
					Static (%)	Dynamic (%)
Rice						
CA 400*	None	100	100	1071	164040-8	-7
TX 1001*	None	124	134	802	130280-8	25
DLT 100-300*	None	114	120	694	227960-8	-22
AK 200*	None	108	114	485	35000-8	-3
Total	Decreasing	110	115	776	132000-8	-8
Cotton						
AL 600	VL	123	125	1225	187090-8	36
CA 500*	None	109	107	2088	144280-8	37
MS 100	None	100	101	1787	72240-8	23
TX 200*	None	101	103	1224	33180-8	78
TX 200	VL	104	100	3283	20980-8	6
Total	Constant	106	105	2020	93323-8	38

[1] Assumes a 10% rate of return to 1982 land values (1978 values for rice)

[2] Assumes a 5% rate of return to 1982 land values (1978 values for rice)

* irrigated

concentration after Mississippi area 100 of the selected rice producing areas. Production and resources are becoming less concentrated in California area 400 at a rate of -2% per year. The trends in relative yield and land prices indicate that comparative advantage in this area will probably remain relatively unchanged. Size economies have been rather fully exploited in this area. The data suggests that the minimum average cost point in rice production is probably reached at the medium enterprise size. The data also suggests that the support price for rice is such that the average revenue curve is substantially above the minimum point on the average cost curve. In this case, ..."firms can achieve a higher profit by extending output beyond that minimum point, even though they experience higher average total costs than smaller firms operating at a low point on the average cost curve" (Madden, 1967, p. 25.)

In Texas area 1001, the comparative disadvantage in rice production increases from 24 to 34% relative to California area 400 when returns to land are reduced from 10% to 5%. This results in Texas area 1001 becoming an even more marginal rice producing area. This is because Texas area 1001's competitive position is associated with less expensive land relative to other rice producing areas. A lower rate of return effectively discounts the source of comparative advantage in rice production in this area.

8.5 Cotton

In cotton production, very large enterprises of about 3000 acres have a 2% cost advantage relative to 650 acre medium size enterprises. The medium and very large cotton enterprises utilize about 1 and 6 two-row harvesters respectively. The change in relative production and resource concentration is positive and increasing at a rate of 10% per year for very large cotton enterprises. The structural elasticity is -77. This indicates that each 77% increase in the average acreage for a cotton enterprise (between 650 and 3000 acres) results in a 1% decrease in production cost. The scoring results are 1 - 1 for very large and medium enterprises respectively. This provides evidence for the existence of relatively constant returns to size in cotton production across the selected producing areas.

In general, the absence of internal size economies in cotton production is the result of statistical averaging. Only three of the five selected cotton producing areas have constant returns to size. These areas include California area 500, Mississippi area 100 and Texas area 200 (irrigated). On the other hand Alabama area 600 and Texas area 200 (dryland) both have increasing returns to size. Size economies exist for Alabama area 600 very large cotton enterprises because these enterprises incur lower machinery and tractor related expenses for a given field operation and still manage to obtain a slightly higher yield. In Texas area 200 (dryland), size economies for very large enterprises relates to the substantial preharvest and ownership cost advantage associated with lower machinery and tractor expenses for a given field operation without substantial loss in yield.

In California area 500, size diseconomies are primarily related to the pecuniary diseconomies of purchased irrigation water for cotton production. In Mississippi area 100, the lack of size economies in cotton production for very large enterprises relates to similar preharvest and ownership costs without significantly higher yields. In

Texas area 200 (irrigated), the lack of size economies is related to the combination of size diseconomies in harvesting and cultivation along with slightly higher yields enjoyed by the medium enterprise in this area.

In terms of comparative advantage, there is a three way tie for comparative advantage in the production of cotton among the selected areas. These three areas are Mississippi area 100 and Texas area 200 both irrigated and dryland. These three areas maintain their comparative advantage (within 2-3 percentage points) regardless of whether returns to land are assumed to be 5 or 10% of its 1982 value. These three areas have an average enterprise size of between 1200 to 3300 acres and have the lowest resource concentration of the cotton areas studied. The percentage change in resource concentration is in all cases positive, ranging from 2 to 20% per year. The trend in relative yield and land prices indicate that Mississippi area 100 will continue to have a comparative advantage relative to Texas area 200 in cotton production. On the other hand, Mississippi area 100 loses comparative advantage in cotton production to Texas area 200 as land returns are reduced. Even though land prices are higher in Mississippi area 100 than Texas area 200, a lower rate of return on land works to the advantage of Texas area 200 because land is a larger percentage of total costs than in Mississippi. In Texas area 200, more of the cotton is planted in strip rows to conserve soil moisture and fewer herbicides or insecticides are used than is the case in Mississippi area 100. The data also suggests that cotton producers in Texas area 200 (dryland) are not operating at the least cost point on their production frontier. We conclude that the quality of the initial resource endowment in Texas area 200 (dryland) provides producers with the ability to remain competitive without the need to fully exploit size economies. As a result Mississippi area 100 and Texas area 200 have nearly equal comparative advantage in cotton production.

In Alabama area 600, the comparative disadvantage in cotton production increases slightly relative to Mississippi and Texas with a 10 and 5% return to land respectively. A decrease in the interest rate (opportunity cost to land investment) does not substantially alter the marginal position of Alabama area 600 in cotton production. The comparative disadvantage in cotton production in Alabama area 600 is due to low relative yields, combined with high fertilizer, lime, insecticide and harvesting costs. Aside from more fully exploiting size economies, Alabama area 600 has few options for increasing its comparative advantage in cotton production in the future.

8.6 Economies of Size

The data suggests the following conclusion regarding internal economies of size for the selected commodities. See Table 100. If we rank the commodities by the weighted structural elasticity in increasing order, then we can get a better picture of the relative "strength" of the economies of size. The evidence is strongest for increasing returns to size for corn and decreasing returns to size for rice given the configurations for enterprise for these commodities in 1983 and 1979 respectively. Each of the selected corn areas have substantial internal economies as enterprise size increases from medium to very large. On the other hand each of the selected rice areas have decreasing returns to size as enterprises size increases from medium to very large.

Table 100. Economies of Size and Structural Elasticities for the Selected Commodities and Areas

Commodity	Returns to Size	Structural Elasticity	Returns to Size: Increasing	Returns to Size: Constant	Returns to Size: Decreasing
Corn	Increasing	-15	IL, IN, IO, NE		
Wheat	Constant	-36	KS, MT	ND	WA
Cotton	Constant	-77	AL, TX	CA, MS, TX*	
Soybeans	Constant	-179	IO	IL, MS	OH
Rice	Decreasing	27			CA*, TX* DLT*, AK*

* irrigated

The strongest case for relatively constant returns to size can be made for cotton. Three of the five selected cotton producing areas have constant returns to size given the configuration of cotton enterprises in 1982. Only Alabama area 600 and Texas area 200 (dryland) have increasing returns to size. Alabama area 600 is a marginal cotton producing area however as indicated by the data on comparative advantage. Texas area 200 (dryland) is one of the most competitive cotton producing areas studied. The average enterprise size in this area is the largest of the selected areas while the percentage change in resource concentration between 1978 and 1982 was the lowest. This seems to indicate that producers of dryland cotton in Texas area 200 are willing to forgo the potential gain associated with expanding enterprise size in order to avoid the additional exposure to risk and uncertaintly. The capital investment in land and machinery required as cotton enterprises in this area expand from 1000 to 6000 acres subtantially increases indebtedness which threatens survivability of the firm. In particular the uncertainty associated with cotton yields in this area of Texas makes heavy indebtedness unattractive.

The arguments for constant returns to size in the cases of wheat and soybeans are somewhat more ambiguous. Selected areas with increasing, constant and decreasing returns to size are present for both of these commodities. In the case of wheat, Kansas area 100 has substantial size economies as enterprises increase from 800 to 4000 acres. This area has the largest average wheat enterprise size of the selected areas and also the lowest change in resource concentration between 1978 and 1982. This seems to indicate that producers of wheat in Kansas area 200 are willing to forgo the potential gains in order to avoid additional exposure to risk and uncertainty associated with expanding enterprise size. A similar case can be made for wheat production in Montana area 200. In the case of soybeans, enterprises in Iowa area 200 have size economies as they increase from 200 to 700 acres. This area has the lowest average enterprise size and lowest percentage change in resource concentration between 1978 and 1982 of the selected soybean areas.

Therefore we conclude that size economies for corn and size diseconomies for rice are consistent and broadly based results. Constant returns to size for soybeans, wheat and cotton exist in general, but important exceptions exist for both economies and diseconomies of size in each of these commodities.

For policy makers, these results imply the following. A structure policies will involve a trade-off with efficiency in the case of corn but probably not in case of soybeans, wheat and cotton. A structures policy of limiting average enterprise size could even potentially increase efficiency in the case of rice. A structures policy may work to the disadvantage of marginal producing areas relative to non-marginal areas because marginal areas appear to more fully exploit size economies as a means to remaining competitive. For soybeans, wheat and cotton, a structures policy involves a trade-off with resource concentration which is the usual justification for a structures policy in the first place.

These results also shed some light on the relation between the various theories on the expected shape of the long-run average cost curve estimated empirically. The L-shaped long-run average cost curve was once again observed in the case of corn, soybean, wheat and cotton. This result was predicted and attributed to internal and external capital rationing. However it was not predicted that rice would exhibit a U-shaped long-run average cost curve. This empirical result is unprecedented. One explanation for this result is not that capital rationing is not at work but rather that an unusually high support price over an extended period of time has over-ridden the constraint of capital rationing. This result indicates, that a case can be made for lowering support prices for rice and/or instituting a limit on rice acreage per farm. At least such policies owuld probably not result in a less efficient industry.

8.7 Size Economies and Comparative Advantage

The data suggests the following conclusions regarding the relationship between size economies and comparative advantage. See Table 101. Enterprises in areas with comparative advantage tend to have unexploited size economies. This is the case with corn and soybeans in Iowa area 201, wheat in Kansas area 100 and cotton in Texas area 200. Conversely, enterprises in areas with a comparative disadvantage tend to more fully exploit size economies presumably as a means of remaining competitive. Examples of this include soybeans in Mississippi area 100, wheat in North Dakota area 200 and rice in Texas area 1001. There are exceptions to these conclusions, but the general rule seems to hold. That is, producers in areas with comparative advantage do not fully exploit size economies but rather include an element of slack in their production operations as a strategy to avoid unnecessary risk and uncertainty. Conversely producers in areas with a comparative disadvantage tend to more fully exploit size economies as a strategy to remain competitive. In effect size economies and comparative advantage highlight the fact that producers necessarily make a trade-~~off be~~tween profitability and survivability. Producers in areas with comparative advantage have the luxury of sacrificing profitability by maintaining smaller enterprise sizes to reduce risk which would threaten survivability. Producers in areas which lack comparative advantage view profitability through fully exploiting size economies as a means of remaining competitive and therefore surviving in the industry.

Table 101. Relationship Between Size Economies and Comparative Advantage for the Selected Commodities.

	Greatest Comparative Advantage			Greatest Comparative Disadvantage		
Commodity	State & Area	Size Economies	Dynamic Herfindahl %/yr	State & Area	Size Economies	Dynamic Herfindahl %/yr
Corn	IO 201	VL	3	NE 400*	VL	5
Soybeans	IO 201	VL	3	MS 100	None	3
Wheat	KS 100	VL	1	ND 200	None	5
Rice	CA 400*	None	-2	TX 1001*	None	6
Cotton	TX 200	VL	2	AL 600	VL	9

* irrigated

The relationship between size economies and comparative advantage provides some insight as to which theory of agricultural development most nearly corresponds to current reality. In general the two competing theories are Cochrane's "treadmill" and G.L. Johnson's "over-production trap." The evidence from this study supports the idea that both theories are at work. In the marginal producing areas both the "treadmill" of technological adoption measured by the exploitation of size economies and the "over-production trap" are in operation. The process probably goes like this. Producers in a marginal area have a large fixed investment in the production of a particular crop both in terms of human and physical capital. This investment has a salvage value which is much lower than acquisition price. Therefore these producers continue to produce and even expand investments in new technologies in order to remain competitive. Once trapped, the treadmill begins as producers continue to adopt cost reducing technologies as a strategy for survival until misfortune or lower product prices forces these producers out of business. Unfortunately producers are not generally willing to go out of production during periods of high product prices since they are likely to believe that their services will be rewarded in the future as well. Consequently producers in marginal agricultural areas will experience declining asset values but will remain in production as long as their assets' value in use is greater than their value as salvage.

In non-marginal areas, another dynamic probably takes place. Producers in non-marginal areas can avoid the over-production trap-treadmill by not over-investing in new capital intensive technology in the first place. Producers in non-marginal areas have the luxury of being less progressive while still remaining competitive. We would expect to find more older and/or obsolete durables used as well as smaller enterprise sizes in areas with a comparative advantage. The largest percentage of corn pickers were found in Iowa. The smallest change in the Herfindahl index was consistently found in areas with comparative advantage.

Tweeten is probably correct though incomplete in his analysis that large firms prevent small firms from earning an equilibrium rate of return. This study supports a hypothesis that large firms in marginal areas prevent small firms in non-marginal areas from earning an equilibrium rate of return. This suggests that the solution to the overproduction problem in U.S. agriculture might well come about through the retiring of large tracts of land in selected locations rather than proportional reductions spread more-or-less uniformly across all production areas. This conclusion is similar to that made by Heady and Skold in a study analyzing potential adjustments necessary in the major field-crop economy of the U.S. in response to projected changes in technology and demand.

> "Although a wide geographical dispersion of land withdrawal from crops is indicated, the general crop production pattern follows existing areas of specialization, but production contracts toward the center of these" (1965, p. 556).

Regional land prices would reflect the relatively depreciated resource value of marginal producing areas.

This inverse relationship between exploited size economies and comparative advantage is consistent with Cyert and March's notions regarding organizational slack (1963, p. 3)., They maintain that information about markets is not automatic, free or riskless. Rather information must be sought after and that producers are not sufficiently motivated to do so until stimulated by some indications of failure. In this case information regarding least cost enterprise size is not sought after until the competitive position is such that the full exploitation of size economies becomes part of a survival strategy. Further, slack is a useful strategy for absorbing shocks to the system. Stable prices reduce but need not eliminate the amount of slack in a system. Corn and soybean producers in Iowa area 201 are in the enviable position of having comparative advantage in both commodities. They are therefore capable of being competitive without being susceptable to a large amount of risk relatively.

8.8 Generalization of Enterprise Results to the Firm

In these concluding remarks regarding resource concentration, size economies and comparative advantage, we can assume that the knowledge of size economies and comparative advantage for an enterprise is a reasonably good proxy for knowledge of size economies and comparative advantage for the entire farm firm. For example, if it is determined that in some areas the reasonable alternatives among the possible field crops are competitive independent commodities, then the farm specializes in the production of a single most profitable commodity so that the enterprise and a farm coincide. Competitive independent commodities are those which require the same inputs at the same time and whose by-products do not aid in the production of the other commodity (Heady, 1952, p. 208). In this study, a case can be made that Texas High Plains Cotton, Great Plains wheat and Texas Upper Gulf Coast rice are examples of competitive independent products.

On the other hand, if it is determined in other areas that the reasonable alternatives among the possible field crops are competitive dependent commodities, then the farm diversifies into the production of two or more of the most profitable commodities. In this case, the farm is a composite of two or more enterprises. The resources of the farm are allocated between commodities so that the marginal value product of the resources used in the production of each commodity are equal. Competitive dependent commodities are those whose by-products aid in the production process of another commodity (e.g., increase fertility, organic matter or moisture; reduce soil erosion, insects, and weeds, etc.) (Heady, 1952, p. 222). Further these commodities are characterized by "increasing rates of product substitution." This means that two or more commodities increase total revenue to the farm through better exploitation of soil types, labor availability while avoiding the peak load problems associated with timely planting and harvesting (Heady, 1952, pp. 214-216). In this study, a case can be made that corn and soybeans in the selected Corn Belt states of Illinois, Indiana, and Iowa; cotton, rice and soybeans in the Mississippi and Arkansas Delta; wheat, barley and rye in the Washington Palouse and irrigated cotton, rice, wheat, sugarbeets and alfalfa in the Sacramento and San Joaquin Valleys of California are examples of competitive dependent products.

In the competitive dependent product case, the relationship between size economies for an enterprise and resource concentration for a firm is less obvious. A relationship does exist however. This relationship relates to the shape of the product-product transformation curve associated with increasing rates of substitution. In particular, if "one product is produced under conditions of constant returns [to scale] and the other is produced under conditions of increasing returns [to scale]" assuming constant resource and product prices, then it can be argued that the presence of scale economies in one enterprise substantially determines resource concentration for the firm as a whole (Heady, 1952, pp. 244-245). This, albeit imperfect correspondence between enterprises and firms in some instances, is the basis upon which statements regarding size economies for a commodity enterprise can be construed to infer an understanding of resource concentration for the farm as a whole.

Probably the biggest problem of using a single enterprise as a proxy for the firm relates to the allocation of a proportion of utilization of machinery, equipment and perhaps some "overhead" type services.

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Background Paper No. 3

Economic Impacts of Selected Policies and Technology on the Economic Viability of Three Representative Cotton Farms in the Texas Southern High Plains

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This background paper was prepared for the assessment "Technology, Public Policy, and the Changing Structure of American Agriculture." The views expressed are those of the author(s) and not necessarily those of OTA.

Economic Impacts of Farm Policies *and Technology on the Economic Viability of* Texas Southern High Plains Cotton Farms

Executive Summary

Three different size cotton farms in the Texas Southern High Plains, representative of a majority of the commerical agriculture production for the region, were analyzed under alternative agricultural policies, federal income tax provisions, technology levels, and financial assistance programs. The purpose of this study was to quantify the impacts of the alternative policies and technology on the growth and economic viability of representative cotton farms. The farms initially operated 1088, 3383, and 5570 acres, reflected debt to asset ratios typical of farms in the area, owned the necessary machinery complement, and farmed both owned and leased acreage.

The results indicate that under the most likely technology scenario and continuation of the provisions of the 1981 Farm Bill, all three representative cotton farms will have a high probability of remaining solvent through 1992. Additionally, all three farms will have an 88% or greater chance of receiving a reasonable return to equity. All three farms will be able to grow over the 10 year planning horizon. The greatest percentage increase in ending farm size was for the 1088 acre farm, followed by the 3383 acre farm, and the 5570 acre farm.

Imposing an acreage reduction program (acreage diversion and set aside) increases net farm incomes and average net present value for all three farms. Acreage reduction programs increase the annual rate of growth more for the 1088 acre farm than for the two larger farms.

Removing the deficiency payment program (income supports) reduced the

probability of survival, net farm incomes, and annual growth rates for all three farms. The greatest percentage decrease in annual net farm income was experienced by the 1088 acre farm followed by the 3383 acre farm. Similarly, the two smaller farms experienced greater reductions in their annual growth rates than the 5570 acre farm.

Removing both price supports (CCC loan) and deficiency payments (income supports) reduced the probability of survival the most for the 1088 acre farm (36 percentage points) while the probability of survival for the 5570 acre farm fell only 2 percentage points. All three farms experienced slower rates of growth in the absence of price and income supports. The annual rate of growth for the 1088 acre farm was reduced five times more than for the 5570 acre farm.

Removing all farm program provisions reduced the probability of survival for all three farms. The probability of survival declined from 92% to 42% for the 1088 acre farm and from 90% to 62% for the 3383 acre farm. The probability of survival for the 5570 acre farm remained above 75%. Average annual net farm incomes for all three farms was substantially less than zero and average net present values were considerably lower than under the current farm program.

Imposing a more restrictive set of federal income tax provisions on the three representative farms reduced the average annual rate of growth more for the two larger farms than for the 1088 acre farm. Net farm incomes were reduced more for the larger farms than for the 1088 acre farm. Growth occurred by leasing as higher taxes reduced available cash for land purchases (downpayments).

Yield enhancing technology anticipated over the next 10 years for cotton did not significantly change the average annual growth rates of the representative farms. Changing the farm program or federal income tax provisions had a greater impact on farm growth than yeild enhancing technology.

The results of analyzing the three farms, assuming they were highly levered, reveal that debt restructuring would not greatly benefit these farms. Their probabilities of survival would not be increased, although the farms were able to remain solvent 1 to 3 years longer. A two year interest subsidy provided greater benefits to net present value, net farm income, and ending net worth than a debt restructure program.

In conclusion, the results of this study indicate that moderate-size (1088 acre) cotton farms in the Texas Southern High Plains are more dependent upon farm program provisions than larger farms for their continued growth and economic viability. Larger farms are better able to survive without farm program benefits because of lower production costs (\$/lb.), higher average cotton lint prices, and a greater asset base from which to meet cash flow deficits. The loss of any farm program provision reduces the economic viability and growth rate of the 1088 acre farm more than the larger farms, however, all size farms are negatively impacted.

Economic Impacts of Farm Policies and Technology on the Economic Viability of Texas Southern High Plains Cotton Farms

The economic impacts of farm policy, income tax provisions, and technology have not been clearly linked to changes in farm structure (Gardner). Numerous economists have suggested that farm programs have accelerated the growth of large scale farms while other economists suggest that the link between government programs and increased farm size has never been empirically demonstrated in a *ceterus paribus* world (Quance and Tweeten; Gardner; Gardner and Pope).

The purpose of this study is to analyze the impacts of selected farm programs, federal income tax provisions, and technology on the viability of three different size cotton farms in the Texas Southern High Plains.

Methodology

The first step in achieving the objectives of this study was to describe three different size representative cotton farms in the study area. The second step, involved a simulation of the representative farms using a Monte Carlo, whole-farm simulation model (FLIPSIM V) under alternative farm policy, income tax, finance, and technology scenarios.

Representative Farms

In 1980 Smith conducted a survey of farmers, bankers, input suppliers, cotton gins, and marketing firms in the Texas Southern High Plains. The survey provided the data necessary to describe representative farms for eight size categories. Within each size category, Smith's farms represent the average characteristics of farms in the region, including volume of cotton produced, cultural practices, machinery complements, financial position, input costs, and marketing strategies. For the present study three of Smith's representative farms were updated for 1982 costs and prices. The three farms selected for this study are the typical size farm in the region (1088 acres); a large-scale farm in the region (3383 acres); and a very large-scale farm in the region (5570 acres). These farms were selected because they typify the scale of commercial agriculture, accounting for 31% of the farms and 62% of the cotton lint produced in the Texas Southern High Plains in 1980.

Table 1 provides a summary of the demographic and financial characteristics for the three representative cotton farms used in the present study. The proportion of cropland owned increases as farm size increases, ranging from 35% for the smallest farm to 62% for the largest farm. The market value of machinery for each farm reflects the 1982 market value of the typical machinery complement for these size farms.

The long- and intermediate-term debt to asset ratios for the 1088 acre farm were obtained from USDA's 1979 Ag. Finance Survey. These debt ratios are the average for part-owner, cotton farmers in the Texas High Plains who had debt on real estate in 1979. Financial ratios reported by Smith for the two larger farms were used because the 1979 Ag. Finance Survey did not provide information for farms in these size categories. Smith's financial ratios for the 1088 acre farm were similar to those reported in the Ag. Finance Survey.

Beginning financial positions of typical farms in each of the three size categories (Table 1) were used, rather than hypothetically assigning a common financial position. Using representative financial data requires the model to recognize the different risk bearing abilities of different size farm operations.

Smith's survey of farmers identified average annual off-farm income

Table 1. Financial Characteristics of Three Representative Cotton Farms by Size in the Texas Southern High Plains.

Characteristics	Farm Size (acres)		
	1088	3383	5570
Age of operator	42	45	51
Acres owned	381	1048	3453
Acres leased	707	2335	2117
Value of owned cropland ($1,000)	222.4	611.7	2,015.4
Value of Machinery ($1,000)	144.5	420.8	713.9
Value of off-farm investments ($1,000)	59.0	110.0	213.7
Beginning cash reserve ($1,000)	16.7	52.0	85.5
Long-term Debt ($1,000)	61.1	120.9	488.7
Intermediate-term Debt ($1,000)	98.3	203.6	475.4
Initial net worth ($1,000)	275.0	854.8	2,032.3
Equity ratio (fraction)[a]	0.62	0.72	0.67
Leverage ratio (fraction)[b]	0.61	0.40	0.49
Long-term debt/asset (fraction)	0.27	0.20	0.24
Intermediate term debt/asset (fraction)	0.68	0.48	0.67
Off-farm income ($1,000)	16.0	0.0	0.0
Minimum family living expenses ($1,000)	15.2	29.1	38.0
Maximum family living expenses ($1,000)	50.0	50.0	60.0

[a] Equity ratio is total net worth by total assets.

[b] Leverage ratio is the ratio of total debt to total net worth.

and minimum family living expenses by farm size (Table 1). These values for family living expenses were used for the present study. Maximum annual family living expenses were assumed to be $50,000 to $60,000 depending on farm size. The model assumes the family will utilize 25 cents of every additional dollar of disposable income, over and above the minimum requirement, for family living. In no instance, however, will family living withdrawals exceed the maximum indicated in Table 1.

Cotton production costs for the three farms were estimated by updating Smith's 1980 production costs to reflect 1982 prices. The two larger farms had a 13% lower total cost of production, per pound of cotton lint, than the 1088 acre farm. The 1982 annual costs of production for irrigated and dryland cotton on the three representative farms assume the same proportional economies in input procurement reported by Smith in 1980. The mix of irrigated and non-irrigated cotton changed across farm size. The 1088 acre farm irrigated 32% of its available cotton acreage while the two larger farms irrigated only 23%. In the simulation analysis, as the 1088 acre farm grew in size, its proportion of irrigated cropland was decreased to 23%.

Simulation Model

The current version of the General Firm Level Policy Simulator -- FLIPSIM V (Richardson and Nixon) was used to simulate the three representative farms for selected policy and technology scenarios. The model is capable of simulating the annual functions of a crop farm, i.e., production, marketing, financial growth and decay, machinery depreciation and replacement, family consumption, incurring fixed and variable costs, and participating in farm programs.

Each representative farm was simulated over the 10-year planning horizon beginning in 1982 and extending through 1992. The planning horizon was then repeated 50 times (iterations) using a different set of random cotton prices and yields for each iteration. At the end of each iteration, values for key output variables were calculated.

The model begins each year of the planning horizon by determining the production costs for the current size of the farm, based on information provided for larger farms. Because the representative farms were permitted to grow over time, cropmix and per acre production costs were forced to change to correspond to larger representative farms.

After determining the relevant cropmix and costs for the farm, the model selects the random crop prices and yields for that year. Random yields for irrigated and non-irrigated cotton and random prices for cotton lint and cottonseed were drawn so as to reflect the historical variability typical of the study area (Table 2).

FLIPSIM V simulates variable production costs for each crop by multiplying the per acre input costs by planted acreages for the respective crops. Labor costs are calculated as the sum of full-time labor charges plus the cost of part-time labor. Part-time labor needs are based on the difference between hours of monthly labor available from full time employees and non-paid family members, and the monthly labor needs for all crops. Harvesting costs are the product of the per unit harvest costs, random yield, and harvested acreage. Each farm's initial production and harvesting costs were expressed in 1982 dollars.

Annual crop yields are selected at random based on the historical yield variability observed for the study area (Table 2), subject to the technology scenario being evaluated, the year of the planning horizon, and the size of farm. Under the base technology scenario it was assumed the

Table 2. Annual Yields and Prices for Typical Cotton Farms in the Texas Southern High Plains, 1974-1983.

Year	Irrigated Cotton lint[a] (lbs/acre)	Non-Irrigated Cotton lint (lbs/acre)	Cotton lint Price[b] ($/lb)	Cottonseed Price[c] ($/ton)
1974	341	83	0.4850	124.0
1975	212	336	0.4756	88.8
1976	553	397	0.6465	100.0
1977	552	355	0.4236	62.0
1978	471	130	0.5566	117.0
1979	369	331	0.5859	120.0
1980	215	65	0.7465	121.0
1981	419	313	0.4540	90.0
1982	0[d]	0[d]	0.4955	95.0
1983	410	276	0.6135	85.0
Means	410	189	0.58	110.3

[a] Cottonseed yield is a linear function of lint yield, averaging about 0.4 tons per bale (480 lbs) of lint.

[b] Cotton lint prices are average cash prices quoted for 41-30 cotton in Lubbock for the second week of December in each year.

[c] Cottonseed prices are season average prices for Lubbock Texas (December-February quotes).

[d] A hailstorm over most of the Southern High Plains reduced yields to zero for both irrigated and dryland cotton.

5570 acre farm would adopt the new technology during years 1-3. The 3383 acre farm was assumed to adopt this technology in a similar pattern during years 4-6 and the 1088 acre farm would make the adoption in years 7-9. Prior to adoption mean yields were set equal to historical averages in Table 2 and after adoption mean yields were held constant at 105% of their historical means.

The model calculates property taxes based on the price of land and the property tax rate for the study area. Other fixed costs are determined by the analyst. The model amortizes all outstanding loans assuming they are simple interest mortgages. Annual interest rates for existing debt on land, machinery, and operating loans were, respectively, 8.5, 13.4, and 14.4%. Annual interest rates for new debts and refinanced loans on long- and intermediate-term assets were 11.4 and 13.4%, respectively. Cash reserves and off-farm investments were allowed to earn 10% interest annually. The market value of farm machinery was updated assuming the real market value of used equipment decreased 1% per year. The market value of cropland was estimated using the historical relationship between the capital gains rate for cropland and the rate of returns for farms. The capital gains rate is a function of the capital gains rate for land in the previous year and the rate of return to production assets for the farm in the previous year.[1]

The model next depreciates each piece of equipment on the farm for income tax purposes. Equipment purchased prior to 1981 was depreciated using the double declining balance method and a 5 to 7 year life. Equipment placed into use after 1980 was cost recovered assuming a 5 year life and the Accelerated Cost Recovery System (ACRS) rules. Regular purpose and special purpose buildings were depreciated using ACRS rules or the double declining balance method where applicable. Equipment that has passed its economic life (7 to 10 years) was replaced by trading the existing piece for a replacement, if sufficient cash was available to cover the required downpayment. The cost of replacement equipment expressed in 1982 dollars was held constant throughout the planning horizon. First year expensing and maximum investment tax credit were calculated for all equipment purchases.

The fraction of each crop marketed in the current tax year was estimated internally based on the operator's desired taxable income ($7,400), estimated cash receipts, and income tax deductions.[2] If the market price is less than the effective loan rate for a crop, it is placed in the CCC loan when available, rather than being sold. Stocks are released from the loan if the market price in the following year exceeds the loan rate plus interest. Deficiency payments are paid if the season average price is less than the target price.[3] The deficiency payment is a function of the payment rate, farm program yield, and harvested acreage. When an acreage set aside or diversion program is simulated, the model reduces planted acreage the specified amount and accounts for increases in production on the more productive land left in production (slippage).

After simulating the farm policies specified by the user, the model determined the farm operator's year-end financial position, calculated family cash withdrawals,[4] and calculated income taxes payable in the following year. Cash surpluses are deposited in an interest bearing account at 10% interest. Year-end cash flow deficits are handled in the following order: (a) grant a lien on crops in storage at the operating loan interest rate, (b) refinance long-term equity, (c) refinance intermediate-term equity, (d) and/or sell cropland. If the operator is unable to cover the deficit in one of these ways, the farm is declared insolvent and the model proceeds to the next iteration after calculating the operator's accrued income and self-employment taxes.

Personal income taxes and self-employment taxes were calculated assuming the operator was married, filed a joint income tax return, and itemized personal deductions.[5] The regular income tax liability was computed using two methods: (a) income averaging (if qualified), and (b) the standard tax tables. The model selected the tax strategy which resulted in the lower income tax liability.[6]

The farm was permitted to grow at the end of each year by purchasing cropland if the operator had cash available (after meeting all expenses) to cover a 30% downpayment for land and a 35% downpayment for any additional machinery necessary for the proposed larger farm. The operator was permitted to borrow against equity in land to meet up to 50% of the downpayment for land. The farm operation could also grow by leasing land if the operator had sufficient cash available to cover the 35% downpayment requirement for purchasing additional machinery required to operate the larger size farm. If machinery was purchased due to growth, the machinery was depreciated, investment tax credit calculated, and the operator's income taxes recomputed.

After checking the farm's prospects for growth, the model updates the farm operator's balance sheet, cash flow statement, and prepares to simulate the next year of the planning horizon. The steps in the simulation process described above are repeated for 10 years or until the farm is declared insolvent. After completing each iteration, the model summarized the information for numerous key output variables and returned the farm to its initial economic situation (year one). This insures that the farm faced the same economic, policy, and physical relationships for each of 50 iterations analyzed.

Policy and Technology Scenarios

The three representative cotton farms were simulated for 10 years under the alternative scenarios described below. Seven farm policy scenarios (including a continuation of the 1981 Farm Bill), one income tax provision scenario, three financial bailout scenarios, and three alternative technology scenarios were simulated for each farm. All policy values associated with each scenario were held constant across farm sizes to allow direct comparison of their impacts on different size farms. Each scenario is described in detail in this section of the report.

Farm Policy Scenarios

1. Base Policy -- The Base Policy Scenario involves continuation of the 1981 Farm Bill through 1992 and continuation of the income tax provisions under the 1982 Tax Act (TEFRA) through 1992. Annual mean crop yields were assumed to increase based on expected adoption of new technology, as indicated in the previous section. For this scenario it is assumed the following farm policies were in effect:

- CCC loan program is available to producers.
- An acreage diversion/set aside program in effect for 1983-1985, was utilized excluding PIK. No acreage diversion/set aside program was in effect for 1986-1992.
- A target price-deficiency payment program is available for cotton in all years.
- The $50,000 payment limitation for deficiency and diversion payments is in effect.

- Farms of all sizes are eligible to participate in these farm program provisions.

Values for loan rates, target prices, diversion rates, and diversion payment rates for 1983, 1984 and 1985 are set at their actual values. Loan rates and target prices for 1986/1992 are held constant at their 1985 levels. Annual loan rates and target prices for Texas cotton used in the analysis are summarized in Table 3 for 1983-1992. Historical farm policy parameters for the Texas cotton farms are outlined in Table 4. The average relationship between loan rates and prices for 1977-1982 was used to determine the average annual prices for cotton lint in 1983-1992. (This was done to minimize any bias caused by setting mean prices too close to either the loan rate or the target price.)

It was assumed the following options for depreciating machinery and calculating income taxes are used for the Base scenario:

- Machinery and buildings placed in use prior to 1981 are depreciated using the double declining balance method.
- Machinery and buildings placed in use after 1980 are depreciated using an accelerated cost recovery method.
- The operator elects to claim first year expensing for all depreciable items.
- The operator elects to take maximum investment tax credit (ITC) and reduce the basis.
- The operator adjusts crop sales across tax years to reduce current year taxes.
- The operator may use either the regular income tax computation or income averaging to calculate federal income tax liabilities.
- There is no maximum interest deduction for calculating taxable

Table 3. Localized Loan Rates and Target Prices for a Representative Cotton Farm in the Texas Southern High Plains, 1983-1992.[a]

Years	Loan Rates Cotton Lint ($/lb)	Target Price Cotton Lint ($/lb)
1983	0.47	0.66
1984	0.46	0.69
1985	0.45	0.68
1986	0.45	0.68
1987	0.45	0.68
1988	0.45	0.68
1989	0.45	0.68
1990	0.45	0.68
1991	0.45	0.68
1992	0.45	0.68

[a] Loan rates and target prices in effect for 1983-1984 and announced for 1984 were localized based on the 1983-84 discount for the typical grade of cotton marketed in Lubbock, Texas in 1982-1983.

Table 4. National Loan Rates and Target Prices for Cotton and Acreage Set Aside/Diversion Rates, 1977-1985.

Year	Loan Rate	Target Price	Set Aside Rate	Diversion	Diversion Payment Rate
	($/lb)	($/lb)	(%)	(%)	($/lb)
1977	0.4463	0.4780	0.00	0.00	
1978	0.4800	0.5200	0.00	0.00	
1979	0.5023	0.5770	0.00	0.00	
1980	0.4800	0.5840	0.00	0.00	0.00
1981	0.5246	0.7087	0.00	0.00	0.00
1982	0.5708	0.7100	0.15	0.00	0.00
1983	0.5500	0.7600	0.20	0.05	0.25
1984	0.5500	0.8100	0.25	0.00	0.00
1985	0.5500	0.8100	0.20	0.05	0.25

income.

- The actual self-employment tax rates and maximum income levels subject to this tax for 1983 and 1984 are used. Announced values for these variables in 1985-1986 were used and the 1986 values were held constant through 1992.
- The operator elects to trade-in old machinery on new replacements at the end of each item's economic life.

II. A 20% Acreage Reduction -- The provisions of the Base Policy Scenario were modified by adding a 15% set aside with a 5% paid diversion for cotton in 1986-1992. Reasonable slippage (70% for cotton) and program participation rates were used to estimate the resulting increase in mean prices in 1986-1992.[7] All other provisions of the Base Scenario were used without change.

III. No Farm Program Payment Limitation -- All provisions of the Base Scenario were used except there was no limitation on diversion and deficiency payments.

IV. No Price Supports and No Deficiency Payments -- The CCC loan and target price provisions under the Base Scenario were assumed to have been eliminated for all years in the planning horizon (1983-1992). Annual mean prices for cotton were decreased 2% based on the expected impact of removing the price and income support programs. Relative variability in prices about their means was increased based on the work of Morton, Devadoss, and Heady as to the effects of no farm program on U.S. agriculture.[8] To isolate the impact of price and income supports on the representative farms, the acreage diversion and set aside programs in the Base Policy for 1983-1985 were assumed to remain in effect.

V. No Target Price/Deficiency Payment -- The target price and deficiency payment provision was assumed to be eliminated for all years of the planning horizon (1983-1992). All other provisions of the Base Scenario were used without change to isolate the effects of only removing the deficiency payment.

VI. Target Farm Program Benefits -- All farm program and income tax provisions of the Base Scenario were used except that farms with more than $300,000 of sales were not eligible to participate in farm program provisions. This program restriction excluded the 5570 acre farm from participating directly in the program provisions (CCC loan, target price/deficiency payments, and set aside-diversions). Mean prices and relative variability in prices were not adjusted because sufficient "smaller" farms were assumed to participate in the farm program for the price support actions of the CCC loan to function normally.

VII. No Farm Program -- All farm program provisions outlined for the Base Scenario were eliminated for all 10 years of the planning horizon. Mean annual prices and relative variance in prices for the No Price and Income Supports Scenario (IV) were used due to eliminating provisions of the CCC loan.

Income Tax Scenarios

VIII. Reduced Income Tax Benefits and Base Farm Program -- The federal income tax provisions in place for the Base Policy Scenario were made more restrictive. All farm policy provisions of the Base Scenario were left unchanged. The more restrictive federal income tax provisions included:

- Machinery and buildings were depreciated using the straight line cost recovery method.
- First year expensing provisions were eliminated for all depreciable items.

- Investment tax credit (ITC) provisions were continued but the maximum ITC provision was eliminated.
- The maximum annual interest expense which could be used to reduce taxable income was $15,600. This value represents the annual interest expense deductions a consumer might have for a home, automobiles, etc.
- The operator must sell obsolete machinery upon disposition rather than trading it in on new replacements, thus forcing recapture of excess depreciation deductions.

All other federal income tax provisions for the Base Scenario were used as outlined earlier.

Financial Stress Scenarios

IX. Base Finance Scenario -- Each farm's long-term debt to asset ratio was increased to 0.55 and its intermediate-term debt to asset ratio was increased to 0.60 to represent a highly leveraged farm. Annual long- and intermediate-term interest rates were increased to their average values for 1980-1983 (.1139 and .1343, respectively) to represent a farm which had been forced to refinance its assets during the past four years. The farm program provisions associated with the Base Policy Scenario (I) are continued for this scenario.

X. Debt Restructure -- The length of intermediate-term loans was increased by 1 year, and a portion of intermediate debt was converted to long-term debt. The conversion of intermediate-term debt was permitted as long as the long-term debt to asset ratio did not exceed 0.65. For some farms, this allowed all intermediate-term debt to be converted to long-term debt while for other farms this constraint substantially restricted debt conversion. Total debt loads and farm program provisions were the same as those used for the Base Finance Scenario (IX).

XI. Interest Subsidy -- The annual interest rates, debt levels, and farm program provisions in the Base Finance Scenario (IX) were simulated but an interest subsidy was provided during the first two years. The interest subsidy took the form of an interest rate reduction equal to 3.4 percentage points for long-term interest rates and 5.4 percentage points for intermediate-term interest rates. These interest rate reductions were the amounts necessary to reduce the respective interest rates (.1137 and .1343) to a 4% rate of interest.

No New Technology Scenarios

XII. No New Technology and Base Farm Policy -- The federal income tax and farm program provisions in the Base Policy Scenario (I) were simulated assuming no increase in mean yields over the planning horizon. For the No New Technology Scenarios, mean irrigated and dryland cotton yields for all 10 years were set equal to their respective means observed over the period 1974-1983 (Table 2).

XIII. No New Technology and No Deficiency Payments -- The farm program provisions in the No Target Price/Deficiency Payments Scenario (V) were simulated assuming the same average annual cotton yields used for the base no new technology scenario (XII).

XIV. No New Technology and No Farm Program -- All farm program provisions were eliminated (Scenario VII) and annual average crop yields used for the base no new technology scenario (XII) were assumed.

Evaluation Criterion

The FLIPSIM V model provides considerable detail as to the viability of a representative farm at the end of each iteration, e.g., ending leverage ratio, ending net worth, ending farm size, total assets, total debt, net present value, and whether the farm remained solvent for 10 years. By repeating each scenario for 50 iterations, the model generates the information necessary to estimate values for key output variables. The means of these key output values are used to compare the economic impacts of selected policy and technology scenarios on representative farms. The following output variables for the model were selected to compare the impacts of the scenarios described in the previous section.

- *Probability of survival* is defined as the probability that the representative farm will remain solvent for 10 years. In other words, it is the probability that the farm operator would maintain at least the minimum financial ratios required by bankers in the local area for all 10 years of the planning horizon, debt to asset ratio less than 0.70.
- *Probability of a positive net present value* is the probability that the representative farm will have a positive after-tax net present value. An after-tax, real discount rate of 3% was used to calculate the farm's net present value. Thus this statistic indicates the probability of the representative farm providing at least a 3% real rate of return to the operator's initial net worth.
- *After-tax net present value (NPV)* is the present value of the operator's annual cash withdrawals (CW) plus the present value of the change in net worth (NW) minus the present value of annual off-farm income (OY):

$$NPV = \sum_{t=1}^{T} \frac{CW_t - OY_t}{(1.03)^t} + \frac{NW_T}{(1.03)^T} - NW_0$$

Cash withdrawals equal family living expenses plus state and federal income taxes and self-employment taxes. Initial net worth (NW_O) and ending net worth (NW_T) explicitly consider the value of off-farm investments and accrued taxes. A 3% after-tax, real discount rate was used to calculate net present value for all representative farms.

- *Present value of ending net worth* is used to indicate the change in the farm's real net worth over the planning horizon. Net worth is affected by increases (or decreases) in asset (land, machinery, and livestock) value and retained earnings. This value can be compared directly to initial net worth to indicate the relative magnitude of real financial growth.
- *Acres owned, leased, and controlled* at the end of the planning horizon for each iteration indicate the impacts of alternative scenarios on the rate of growth for representative farms. These three statistics provide an indication of how the farm grew either by purchasing or leasing land.
- *Total long- and intermediate-term debts* at the end of the planning horizon provide an insight into the financial stress of the farm over the planning horizon. Increases in average ending debt from one scenario to another can be due to either rapid growth through purchasing land and machinery or the farm operator being forced to refinance large cash flow deficits. When surplus cash is available, the operator is permitted to first prepay intermediate-term debts and then prepay new long-term debts. Therefore large ending intermediate-term debts indicate insufficient cash was available to reduce intermediate-term debt through prepayment of principal.

- *Ending equity ratio* is the farm's ending ratio of total net worth to total assets. This ratio provides a "bottom-line" measure for comparing the representative farm's ending financial position across scenarios.
- *Average Annual Net Farm Income* is the average net farm income received by the operator over all years simulated. Net farm income equals total farm receipts plus total government payments minus all cash production expenses, interest payments, labor costs, fixed cash costs, and depreciation. This value excludes all non-farm income and interest earned on cash reserves.
- *Average Annual Government Payment* is the average annual government payment (deficiency and diversion payments) received over all years simulated.

Results

The results of simulating Scenarios I-VIII for the three representative cotton farms are summarized in Tables 5-7. Under the Base Policy Scenario, all three farms had a 90% or greater chance of remaining solvent for 10 years and an 88% or greater chance of receiving a positive net present value. All three farms were able to increase their real net worth on the average and two of the farms increased their average ending equity ratio. In addition, all three farms were able to increase the average total number of acres they controlled. The 1088 acre farm grew 470 acres (43%) over the 10 year planning horizon, while the 3383 and 5570 acre farms grew by 26.7% and 7.7%, respectively.

Acreage Reduction Program

Imposing a 20% acreage reduction program on the three cotton farms

Table 5. Comparison of Selected Policy Secenarios on a Representative 1088 Acre Texas Southern High Plains Cotton Farm.

Criteria	Initial Situation	Alternative Scenarios[a] I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	--	92	94	94	56	68	92	42	88
Probability of Positive Net Present Value (%)	--	92	94	94	48	56	92	32	88
After-tax net present value mean ($1,000)	--	381.3	473.6	427.9	-16.8	48.8	380.8	-95.2	364.4
Average present value of ending net worth ($1,000)	275.0	563.9	648.3	600.9	241.8	300.9	563.7	167.1	516.0
Average ending cropland owned (acres)	381.0	598.4	665.3	681.6	372.1	403.6	598.4	283.6	579.1
Average ending cropland leased (acres)	707.0	960.0	969.9	966.4	843.9	870.0	960.0	929.2	985.7
Average ending cropland controlled (acres)	1088.0	1558.4	1635.2	1647.9	1216.0	1273.6	1558.4	1212.8	1564.8
Average ending long-term debts ($1,000)	61.0	135.8	153.1	186.4	89.9	95.7	136.6	68.9	148.4
Average ending intermediate-term debts ($1,000)	98.3	23.9	15.7	21.2	105.5	84.9	23.9	128.5	37.2
Average ending equity ratio (fraction)	0.62	0.75	0.77	0.74	0.46	0.57	0.71	0.28	0.70
Average internal rate of return (fraction)	--	0.08	0.10	0.09	-0.12	-0.03	0.08	-0.21	0.07
Average annual net farm income ($1,000)	--	8.3	13.3	11.9	-28.9	-21.7	8.2	-40.6	-6.0
Average annual gov't payment ($1,000)	--	26.0	22.2	29.5	1.3	1.1	25.9	0.0	25.8

[a] The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program

Table 6. Comparison of Selected Policy Secenarios on a Representative 3383 Acre Texas Southern High Plains Cotton Farm.

Criteria	Initial Situation	Alternative Scenarios[a] I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	--	90	94	94	72	82	86	62	88
Probability of Positive Net Present Value (%)	--	88	94	94	68	80	86	60	88
After-tax net present value mean ($1,000)	--	960.6	1289.5	1540.5	375.6	535.6	680.5	217.4	945.3
Average present value of ending net worth ($1,000)	854.8	1412.4	1696.8	1853.4	930.5	1054.5	1191.3	800.7	1225.7
Average ending cropland owned (acres)	1048.0	1813.9	1945.2	2095.6	1331.5	1455.4	1541.9	1275.6	1468.4
Average ending cropland leased (acres)	2335.0	2474.6	2509.8	2481.0	2416.3	2401.2	2442.6	2373.0	2497.0
Average ending cropland controlled (acres)	3383.0	4288.6	4455.0	4576.6	3747.8	3856.6	3984.6	3648.6	3965.4
Average ending long-term debts ($1,000)	120.9	458.3	430.0	443.3	269.5	289.0	333.5	273.3	360.4
Average ending intermediate-term debts ($1,000)	203.6	92.7	73.6	58.6	216.3	168.9	126.3	242.9	107.3
Average ending equity ratio (fraction)	0.72	0.69	0.75	0.75	0.60	0.65	0.69	0.52	0.67
Average internal rate of return (fraction)	--	0.07	0.11	0.12	0.00	0.05	0.05	-0.08	0.08
Average annual net farm income ($1,000)	--	33.4	53.6	83.3	-14.8	3.6	12.9	-39.7	-7.2
Average annual gov't payments ($1,000)	--	38.0	35.1	83.3	3.2	3.0	16.8	0.0	37.9

[a] The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program

Table 7. Comparison of Selected Policy Seccenarios on a Representative 5570 Acre Texas Southern High Plains Cotton Farm.

Criteria	Initial Situation	Alternative Scenarios[a] I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	--	94	96	98	92	96	88	78	94
Probability of Positive Net Present Value (%)	--	90	94	98	70	84	76	66	84
After-tax net present value mean ($1,000)	--	1595.2	2148.1	2905.5	811.4	1151.1	722.4	469.4	1574.4
Average present value of ending net worth ($1,000)	2032.3	3027.3	3489.0	4046.7	2366.6	2645.4	2286.7	2066.4	2583.3
Average ending cropland owned (acres)	3453.0	3530.9	3716.7	4207.6	3086.0	3352.5	3064.5	3011.7	3317.9
Average ending cropland leased (acres)	2117.0	2471.1	2330.1	2306.4	2695.2	2495.9	2662.3	2724.6	2428.1
Average ending cropland controlled (acres)	5570.0	6001.9	6046.8	6514.0	5781.2	5848.4	5726.8	5736.3	5746.0
Average ending long-term debts ($1,000)	488.7	519.4	425.6	477.4	542.2	545.6	540.5	559.3	790.1
Average intermediate-term debts ($1,000)	475.4	112.6	107.1	60.0	190.7	146.9	207.7	271.5	152.1
Average ending equity ratio (fraction)	0.67	0.79	0.84	0.85	0.71	0.77	0.76	0.68	0.71
Average internal rate of return (fraction)	--	0.07	0.10	0.13	0.05	0.06	0.01	-0.06	0.08
Average annual net farm income ($1,000)	--	66.6	100.6	170.6	-3.2	31.0	-13.9	-40.5	-15.6
Average annual gov't payments ($1,000)	--	40.2	39.1	135.8	4.8	4.6	0.0	0.0	40.4

[a] The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program

(Scenario II) increased their probabilities of survival, their probability of experiencing a positive net present value, average net present value, and average ending farm size over the Base Scenario. These results are to be expected because an acreage reduction program increases mean cotton price and provides a small diversion payment to defray the costs of participating in the acreage reduction program. The increase in average ending farm size due to the 20% acreage reduction program ranges from 1% for the 5570 acre farm to 4.9% for the 1088 acre farm. Average annual government payments to all three farms are less than under the Base Scenario because higher mean cotton prices reduce deficiency payment rates and thus total government payments.

No Payment Limitation

Eliminating the $50,000 payment limitation (Scenario III) resulted in substantial increases in average annual government payments for the 5570 and 3383 acre farms while only marginally impacting the 1088 acre farm. Average net present value for the 5570 acre farm was increased 82% over the Base Scenario as a result of eliminating the payment limitation. In contrast, average net present value for the 1088 acre farm was increased 12% by eliminating the $50,000 limitation. Average ending farm size for the 5570 acre farm was increased 8.5% over the Base by eliminating the payment limitation while ending farm size for the 1088 acre farm was increased 5.7%. The incentive exists for larger farms to restructure their operations to obtain maximum benefit of deficiency payments.

No Price and Income Supports

Removing both price and income supports (Scenario IV) reduced the probabilities of survival 2 percentage points for the 5570 acre farm, 18 percentage points for the 3383 acre farm, and 36 percentage points for the 1088 acre farm. Average annual net farm income for the 1088 acre farm declined from $8,300 under the Base Policy Scenario to -$28,300 and average net present value declined 104% to -$16,800. Average net present value for the 5570 acre farm was reduced about 50% to $811,400. Average ending farm size for the 1088 acre farm was 21.9% less than the Base Scenario while the ending farm size for the 5570 acre farm was only 3.6% less than the Base.

The loss of price and income supports increased the relative variability (risk) in net present value more for the 1088 acre farm than the 5570 acre farm. These results are to be expected when price supports and deficiency payments are removed. Those farms with higher profit margins, greater equity, and higher mean yields should be better able to survive if price and income supports are removed.

No Income Supports

Removing the target price/deficiency payment (Scenario V) reduced the probability of survival substantailly more for the 1088 acre farm than for the 5570 and 3383 acre farms. This result is not all that surprising given the finding under Scenario III. An effective payment limit of $50,000 sufficiently reduces the benefits derived from the target price/deficiency payment provisions for the larger farms. Therefore the elimination of such a program will not be as painful. The loss in deficiency payments reduced average annual government payments $25,000 for the 1088 acre farm and $35,400 for the largest farm. On a per acre basis, this reduction in receipts was 343% greater for the small farm than the large farm, thus further explaining the significant differences in the results of this scenario for the two farms.

In the event that farm program provisions were targetted to farms producing $300,000 or less in cotton (Scenario IV), only the 1088 acre farm would be able to participate in the farm program during all years. The 3383 acre farm would receive only 44% as great an average government payment as under the Base, due to such a program and the 5570 acre farm would not be able to participate directly in any farm program provisions. Probabilities of survival for the 3383 and 5570 acre farms fell to 86% and 88%, respectively, but they did not fall to the low levels experienced under Scenario IV when price and income supports were removed. The reason being that although these large farms can not benefit directly from price supports, they indirectly gain the benefits of reduced price variability due to other farmers participating in the loan program. This type of farm program would not reduce the rate of growth in farm size for the 1088 acre farm; however, it would substantially reduce the rate of growth for the two larger farms.

No Farm Program

Removing all farm program provisions substantially reduced the probability of survival for all three farms (Scenario VII). The greatest reduction in the probability of survival was for the 1088 acre farm and the least reduction was for the 5570 acre farm. On average, the 1088 acre farm was forced to sell 100 acres to achieve a 42% chance of remaining solvent for 10 years. The 5570 acre farm was able to remain solvent 78% of the time but only by selling an average of 440 acres over the planning horizon. Average annual net incomes for all three farms fell below zero by about $40,000 due to lower mean cotton prices, increased price variability, and the absence of deficiency payments. The only difference between this scenario and Scenario IV (no price and income supports) is that Scenario IV included a set aside and paid diversion in 1983-1985, with the associated price enhancement. Net present value, net worth, and probability of survival for all three farms were significantly benefitted by price enhancement and diversion payments during 1983-1985.

More Restrictive Income Taxes

Imposing a more restrictive set of federal income tax provisions reduced the probability of survival slightly more for the 1088 acre farm than the 3383 acre farm and had no effect on the 5570 acre farm's chances for survival. Average net present value was reduced about $20,000 for all three farms. Average ending farm size was reduced from the Base about 7.5% for the 3383 acre farm and about 4.3% for the 5570 acre farm. As expected, increasing the federal income tax burden reduced the propensity of farms tc grow through purchasing cropland in favor of growing-through leasing. Total cropland controlled at the end of the planning horizon was about the same as the Base for the 1088 acre farm while ending farm size was 4 to 7% lower than the Base for the two larger farms.

Financial Bailout Strategies

To analyze the benefits of alternative financial bailout strategies, the financial positions for the three representative farms described in Table 1 were modified to emulate highly levered farms and simulated under the Base Policy scenario with alternative bailout strategies in place. The long-term debt to asset ratio for each farm was increased to 55%, the intermediate-term debt to asset ratios were set equal to 60%, annual interest rates were increased to their average values for 1980-1983 (11.37% for long term and 13.4% for intermediate term), and off-farm investments were set equal to zero. As a basis for comparison these highly leveraged farms were simulated for 10 years using the farm policy and income tax provisions in the Base Policy Scenario (I). The results of simulating this Base Financial Scenario and the two financial bailout strategies are presented in Tables 8-10.

All three highly levered cotton farms have a low probability of remaining solvent for 10 years (56 to 66%) under the Base Policy Scenario (IX). Restructuring debt (Scenario X) for the three different size cotton farms did not appreciably improve their chances of survival. In fact, this type of financial assistance actually encouraged all three farms to grow through land purchases which resulted in lower probabilities of survival for two larger farms. On the other hand, an interest rate buydown program moderately increased the probability of survival for the two smaller (1088 and 3383 acre) farms and substantially increased the average net present value and ending net worth for all three.

An interest rate subsidy resulted in an increased average annual net farm income for all three farms, while the debt restructure actually reduced the average annual net farm income. Overall, the interest rate subsidy provided a greater benefit than the debt restructure bailout.

No New Technology

The simulation results presented thus far assumed the most likely technology scenario for the 10 year planning horizon. This amounted to a 5% increase in cotton yields being fully adopted in the first three years by the 5570 acre farm, being adopted in years 4-6 for the 3383 acre farm, and adopted in years 7-9 for the 1088 acre farm. As a point of comparison three of the policy scenarios were re-analyzed assuming no new technology was adopted by the three farms. The results of these no new technologies scenarios are summarized in Tables 11-13. To evaluate the impact of tech-

Table 8. Comparison of Selected Financial Bailout Scenarios for a Representative 1088 Acre Texas Southern High Plains Cotton Farm.

	Alternative Scenarios[a]		
Criteria	IX	X	XI
Probability of Survival (%)	64	66	72
Probability of Success (%)	64	66	72
After-tax net present value mean ($1,000)	204.7	212.8	252.5
Average present value of ending net worth ($1,000)	303.6	313.6	343.2
Average ending cropland owned (acres)	464.3	522.4	492.9
Average ending cropland leased (acres)	950.1	911.2	950.3
Average ending cropland controlled (acres)	1414.4	1433.6	1443.2
Average ending long-term debts ($1,000)	160.3	204.6	170.8
Average intermediate-term debts ($1,000)	68.6	72.7	53.7
Average ending equity ratio (fraction)	0.40	0.37	0.51
Average internal rate of return (fraction)	0.00	0.04	0.07
Average annual net farm income ($1,000)	-5.4	-6.4	1.3
Average annual gov't payment ($1,000)	24.4	24.8	24.7

IX Base Finance Scenario consists of the Base farm program provisions for a highly leveraged farm

X Restructure debt for a highly leveraged farm

XI Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

Table 9. Comparison of Selected Financial Bailout Scenarios for a Representative 3383 Acre Texas Southern High Plains Cotton Farm.

	Alternative Scenarios[a]		
Criteria	IX	X	XI
Probability of Survival (%)	56	50	60
Probability of Success (%)	56	52	60
After-tax net present value mean ($1,000)	429.4	413.1	582.3
Average present value of ending net worth ($1,000)	604.3	599.6	732.9
Average ending cropland owned (acres)	1029.4	1180.4	1207.8
Average ending cropland leased (acres)	2740.8	2660.2	2613.5
Average ending cropland controlled (acres)	3770.2	3840.6	3821.4
Average ending long-term debts ($1,000)	353.1	481.7	418.4
Average intermediate-term debts ($1,000)	242.3	256.5	218.7
Average ending equity ratio (fraction)	0.28	0.40	0.35
Average internal rate of return (fraction)	0.00	0.01	0.04
Average annual net farm income ($1,000)	-9.1	-21.2	6.9
Average annual gov't payment ($1,000)	36.8	36.4	37.2

IX Base Finance Scenario consists of the Base farm program provisions for a highly leveraged farm

X Restructure debt for a highly leveraged farm

XI Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

Table 10. Comparison of Selected Financial Bailout Scenarios for a Representative 5570 Acre Texas Southern High Plains Cotton Farm.

	Alternative Scenarios[a]		
Criteria	IX	X	XI
Probability of Survival (%)	66	64	66
Probability of Success (%)	62	60	64
After-tax net present value mean ($1,000)	495.3	529.3	834.4
Average present value of ending net worth ($1,000)	1310.2	1356.3	1619.0
Average ending cropland owned (acres)	2443.1	2651.7	2665.7
Average ending cropland leased (acres)	3290.0	3324.7	3105.9
Average ending cropland controlled (acres)	5733.2	5976.4	5771.6
Average ending long-term debts ($1,000)	830.3	1068.5	858.4
Average intermediate-term debts ($1,000)	348.9	356.7	301.7
Average ending equity ratio (fraction)	0.41	0.46	0.44
Average internal rate of return (fraction)	0.09	0.10	0.13
Average annual net farm income ($1,000)	-41.8	-57.3	-6.3
Average annual gov't payment ($1,000)	41.1	41.3	41.6

IX	Base Finance Scenario consists of the Base farm program provisions for a highly leveraged farm
X	Restructure debt for a highly leveraged farm
XI	Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

nology on the three farms, one must compare the results in Tables 11-13 to their respective results in Tables 5-7.

Due to its early adoption, the 5570 acre farm benefitted more from the new technology than the other two farms. The value of adopting the new technology early is evident in the added net present value for the 5570 acre farm. Under the Base Scenario (I) this farm enjoys a $250,000 increase in average net present value due to early adoption of the new technology. In contrast, the 1088 acre farm had a $16,000 higher average net present value (under the Base Policy Scenario) due to the adoption of new technology.

Despite the substantial contribution technology made to net present value for the 5570 acre farm, average ending farm size is about the same (less than 50 acres greater) due to the early adoption of new technology. Similarly, for the two smaller farms, average ending farm size is almost identical for the two different levels of technology. These results suggest that farm programs have far more impact on a farm's economic viability and growth than moderate technological advancements in crop agriculture.

Summary of Results

Base Policy Scenario

- All three representative farms had a high probability of remaining solvent through the 10 year planning horizon.
- All three farms had greater than a reasonable (greater than 88%) chance of having a positive net present value.
- On the average, all three farms were able to grow by purchasing and leasing cropland.
- The greatest percentage increase in ending farm size was for the 1088 acre farm; however, the 3383 acre farm had the greatest absolute increase in acres controlled.

Table 11. Comparison of Selected Farm Policy Scenarios Assuming No New Technology Scenario for a 1088 Acre Texas Southern High Plains Cotton Farm.

Criteria	Initial Farm	Alternative Scenarios[a] XII	XIII	XIV
Probability of Survival (%)	--	92	68	42
Probability of Positive Net Present Value (%)	--	92	54	30
After-tax net present value mean ($1,000)	--	365.4	37.3	-102.2
Average present value of ending net worth ($1,000)	275.0	551.5	290.4	160.8
Average ending cropland owned (acres)	381.0	627.2	400.4	283.6
Average ending cropland leased (acres)	707.0	963.2	879.6	922.8
Average ending cropland controlled (acres)	1088.0	1590.4	1280.0	1206.4
Average ending long-term debts ($1,000)	61.0	158.4	94.5	70.0
Average ending intermediate-term debts ($1,000)	98.3	25.5	87.0	130.1
Average ending equity ratio (fraction)	0.62	0.73	0.56	0.26
Average internal rate of return (fraction)	--	0.08	-0.04	-0.17
Average annual net farm income ($1,000)	--	7.0	-22.2	-41.0
Average annual gov't payments ($1,000)	--	26.3	1.1	0.0

[a] XII -- Base Policy, continuation of 1981 Farm Bill, assuming most likely yields.
XIII -- No Target Price/Deficiency payments assuming most likely yields.
XIV -- No Farm Program assuming most likely yields.

Table 12. Comparison of Selected Farm Policy Scenarios Assuming No New Technology Scenario for a 3383 Acre Texas Southern High Plains Cotton Farm.

Criteria	Initial Farm	Alternative Scenarios[a] XII	XIII	XIV
Probability of Survival (%)	--	88	78	60
Probability of Positive Net Present Value (%)	--	86	76	56
After-tax net present value mean ($1,000)	--	860.0	432.3	146.4
Average present value of ending net worth ($1,000)	854.8	1324.5	966.2	738.4
Average ending cropland owned (acres)	1048.0	1772.4	1423.4	1259.6
Average ending cropland leased (acres)	2335.0	2500.2	2394.8	2373.0
Average ending cropland controlled (acres)	3383.0	4272.6	3818.2	3632.6
Average ending long-term debts ($1,000)	120.9	470.3	308.3	286.3
Average ending intermediate-term debts ($1,000)	203.6	107.5	182.6	263.8
Average ending equity ratio (fraction)	0.72	0.67	0.62	0.48
Average internal rate of return (fraction)	--	0.07	0.03	-0.10
Average annual net farm income ($1,000)	--	25.4	-3.6	-45.5
Average annual gov't payments ($1,000)	--	37.9	3.0	0.0

[a] XII -- Base Policy, continuation of 1981 Farm Bill, assuming most likely yields.
XIII -- No Target Price/Deficiency payments assuming most likely yields.
XIV -- No Farm Program assuming most likely yields.

Table 13. Comparison of Selected Farm Policy Scenarios Assuming No New Technology Scenario for a 5570 Acre Texas Southern High Plains Cotton Farm.

Criteria	Initial Farm	Alternative Scenarios[a]		
		XII	XIII	XIV
Probability of Survival (%)	--	94	90	76
Probability of Positive Net Present Value (%)	--	86	74	60
After-tax net present value mean ($1,000)	--	1340.8	780.8	210.8
Average present value of ending net worth ($1,000)	2032.0	2806.5	2322.4	1842.6
Average ending cropland owned (acres)	3453.0	3487.1	3250.4	2988.2
Average ending cropland leased (acres)	2117.0	2473.3	2566.0	2735.4
Average ending cropland controlled (acres)	5570.0	5960.4	5816.4	5723.6
Average ending long-term debts ($1,000)	488.7	601.0	624.3	641.6
Average ending intermediate-term debts ($1,000)	475.4	130.3	209.9	324.3
Average ending equity ratio (fraction)	0.67	0.80	0.71	0.81
Average internal rate of return (fraction)	--	0.08	0.04	-0.07
Average annual net farm income ($1,000)	--	47.0	0.2	-65.9
Average annual gov't payments ($1,000)	--	40.5	4.8	0.0

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[a] XII -- Base Policy, continuation of 1981 Farm Bill, assuming most likely yields.
XIII -- No Target Price/Deficiency payments assuming most likely yields.
XIV -- No Farm Program assuming most likely yields.

Acreage Reduction Programs

- Average net present value was increased for all three farms as a result of an acreage reduction program.
- A 20% acreage reduction program increased average ending farm size about 1% for the 5570 acre farm and about 5% for the 1088 acre farm.
- Average ending equity to asset ratios for all three farms were increased 2 to 6 percentage points by a 20% acreage reduction program.
- Net farm income was increased more than 50% for the three Texas cotton farms.
- Deficiency payments were reduced from 3 to 15% for the three farms.

No Payment Limitation

- The larger the farm, the greater the impacts on growth and income from removing the $50,000 payment limitation on deficiency and diversion payments. Average net present value increased 82% for the 5570 acre farm, 60% for the 3383 acre farm, and 12% for the 1088 acre farm.
- Removing the payment limitation substantially increased the average ending farm size. On the average, the 5570 acre farm grew 8.5% more than the Base, while the 3383 and the 1088 acre farms grew 6.7 and 5.7%, respectively.

No Price Supports and No Deficiency Payments

- Removing price and income supports for cotton reduced the probability of survival for all three farms. The probability of survival for the 1088 acre farm declined the most.
- Average after-tax net present value was decreased 104% for the 1088 acre farm and 50% to 60% for the two larger farms.
- The loss of price and income supports substantially reduced the rate of growth in farm size for the 1088 acre farm (22%) while only moderately reducing the rate of growth for the largest farm (4%).
- Loss of price and income supports increased risk associated with income more for the 1088 acre farm than for the larger farms.
- The presence of an effective $50,000 payment limitation causes the income support program to benefit the 1088 acre farm relatively more than larger farms. In contrast, the price support program results in a greater relative advantage for large and very large farms.

No Target Price/Deficiency Payment

- Removing the deficiency payment provision reduced the probability of survival considerably more for the 1088 acre farm than for the 3383 or 5570 acre farms. The probability of survival declined from 94% to 68% for the smallest farm.

- The $50,000 payment limitation, if effective, reduced the current benefits of the deficiency payment for very large farms, so its loss reduced average ending farm size less than 2.5%.

- The loss of deficiency payments reduced the average net present value of small farms more than twice as much as for large farms.

- Average ending farm size was reduced more, in percentage terms, for the small farm (-18%) than for the large farm (-2.5%) if deficiency payments were removed.

Target Farm Program Benefits to Small Farms

- The two larger farms were prevented from participating in the CCC loan, diversion program, and deficiency payment, in most years, due to their value of production exceeding the maximum of $300,000.

- The 1088 acre farm was not affected by the program. However the rate of growth for the two larger farms was reduced about 50% from the Base.

- Although the two larger farms were unable to place cotton in the CCC loan they benefited indirectly from the price stabilizing functions of the loan.

No Farm Program

- Removing all farm program provisions reduced the 1088 acre farm's chance of remaining solvent for 10 years from 92% to 42%, while the chance of remaining solvent for the 5570 acre farm declined from 94% to 78%.

- The percentage reduction in average net present value was similarly reduced more for the smallest farm than for the largest farm.

- In the absence of farm programs, all three farms continued to grow but at a much slower rate than under the Base farm program. The largest farm was able to increase its average ending farm size 166 acres over its initial 5570 acres. Average ending farm size increased about 124 acres for the smallest farm; however, it survived only 42% of the time.

- The largest farm was forced to sell an average of 441 acres to remain solvent 78% of the time for 10 years.

- Removal of all farm program benefits reduced average ending net worth for all three farms due to reductions in land values.

More Restrictive Federal Income Tax Provisions

- More restrictive federal income tax provisions reduced the average annual rate of growth more for the two larger farms than for the 1088 acre farm.

- Increasing the federal income tax burden on farmers reduced the propensity to grow through purchasing cropland relative to leasing.

- Probability of survival was not significantly affected by a more restrictive set of federal income tax provisions.

- Changes in the tax provisions resulted in reduced annual net farm incomes on all three cotton farms. Reduction in net farm income was greater for the largest farm than for the moderate-size farm.

Financial Bailout Strategies

- Restructuring initial debt for highly leveraged farms failed to appreciably increase the probability of survival for the three Texas cotton farms.

- Debt restructure resulted in accelerated farm growth in later years, which contributed to low probabilities of remaining solvent for 10 years.

- An interest rate buy-down strategy increased the probability of survival only slightly for the smaller two farms while not affecting the largest farm's probability of survival.

- Average ending farm size for an interest buy-down program was only slightly greater than for the Base Financial analysis.

- Neither debt bailout strategy provided much hope for highly leveraged Texas Southern High Plains cotton farmers without substantial off-farm income to subsidize the farm.

Impact of Technology

- Increasing average annual cotton yields had no significant impact on the average growth rate for the three Texas cotton farms. This result was the same for all three farm policies evaluated.

- Farm policies and federal income tax provisions had substantially more impact on the average growth rate for the three Texas cotton farms than yield differences between the most likely technology scenario and the no new technology scenario.

Footnotes

[1] The annual capital gain rate for cropland (cgrate) is calculated as a function of the lagged capital gain rate and the real rate of return to production assets (rret) in the previous period:

$$\text{cgrate} = \underset{(-1.37)}{-0.0559} + \underset{(1.76)}{0.0582}\ \text{Dummy} + \underset{(1.73)}{0.3673}\ \text{cgrate}_{t-1} + \underset{(3.46)}{2.490}\ \text{rret}_{t-1}$$

The Dummy variable is one for 1979 and 1980 and zero otherwise and the student -t ratios are below their respective coefficients. The R square for this equation was 68.6% and the F ratio was 6.55. The coefficients were estimated using national capital gain rates for farmland (USDA, *Farm Real Estate Market Developments*) and national residual returns to farm assets as a percent of total assets (pages 105-106, USDA, *Economic Indicators*).

[2] Income tax consequences frequently determine the fraction of crops sold during the income tax year they are harvested. The first step in calculating this fraction is to determine the operator's expected income tax deductions and cash receipts. Estimated deductions include: fixed costs, interest payments, variable production and harvesting costs, labor costs, cash rent for land, depreciation, crop insurance premiums, and personal income deductions ($1,000 per dependent plus excess itemized deductions). Estimated cash receipts include: value of all crops if sold in the current tax year; value of crops held over from the previous year and sold in the current year; all off-farm income; and other farm income. If estimated cash receipts are less than estimated tax deductions plus the targeted taxable income ($7,400), all crop production is sold in the current tax year. When cash receipts exceed deductions plus

$7,400, the proportion of crops sold in the next tax year equals the percentage of the crop that must be carried over for current cash receipts to equal deductions plus $7,400.

[3] The 1981 Farm Bill indicates deficiency payments for cotton shall be based on annual average prices received by farmers. Since weighted average annual prices received by farmers in the Lubbock area are not available for cotton and sorghum, the model calculated deficiency payments for both cotton and sorghum using season average prices. Target prices and loan rates for cotton were scaled down 8.3 cents per pound to account for locational and quality differentials between Lubbock prices and national average cotton prices used to calculate deficiency payment rates. This adjustment forced the maximum deficiency payment rate to be equal to the value one would have used for a national policy simulation model.

[4] A linear family consumption function was assumed for farmers in the Texas Southern High Plains. The function assumed a minimum level of annual family living expenses was incurred regardless of the farm's financial condition. Beyond the minimum, the operator had a 0.25 marginal propensity to consume out of disposible income. The consumption function was bounded on the top side by a maximum level of annual family living expenses (Table 1).

[5] Depreciation recapture, capital gains and losses, investment tax credit, and depreciation allowances are explicitly accounted for in calculating the sole proprietor's accrued income tax liability. If there is a net operating loss from prior years, taxable income in the current year is appropriately reduced. If there is a net operating loss in the current year, it is automatically carried forward. Net operating loss carryback

is not permitted in the model.

[6] All investment tax credit allowances were deducted from the regular tax liability and the result was compared to the income tax liability under the alternative minimum tax. The operator paid the excess of the alternative minimum tax over the sum of the regular income tax liability and the regular minimum tax. Income tax rate schedules for 1981, 1982, 1983, and 1984 were included in the model, as well as a procedure to develop tax rate schedules for 1985-1990 based on changes in the Consumer Price Index.

[7] The price response from a 15% acreage set-aside and 5% diversion was calculated assuming the own price flexibility for cotton was -1.75, slippage was 70%, and program participation was 80%. Based on these assumptions the price response would be about 8.4%, so the annual mean cotton prices in Table 3 were increased 8.4% in 1986-1992.

[8] Morton, Devadoss, and Heady estimated the effect of removing all farm programs on corn and wheat. Their results suggest that the relative variability in the price of wheat and corn would increase 207% and 131%, respectively, and the mean prices for these crops would decline 1% and 8%. One would expect that removing price supports (CCC loan and FOR) would increase the variability of wheat price more than that of corn price because these price support mechanisms have influenced the season average price of wheat more frequently than the corn price over the past decade. Increased relative variability in the price of cotton is assumed to increase 160% or the average of the increases reported for wheat and corn by Morton, Devadoss, and Heady. Cotton farmers have depended on the loan to establish a floor price less frequently than wheat farmers, but

more frequently than corn producers over the past decade.

The expected change in the mean price of cotton due to removing the CCC loan is to decrease the mean price for Texas High Plains cotton farmers about 2%. This decrease was estimated by calculating the mean price of cotton in the High Plains using the empirical distribution for cotton price in Table 3, both with and without the CCC loan.

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Background Paper No. 4

Economic Impacts of Selected Policies and Technology on the Economic Viability of Three Representative Wheat Farms in the High Plains

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This background paper was prepared for the assessment "Technology, Public Policy, and the Changing Structure of American Agriculture." The views expressed are those of the author(s) and not necessarily those of OTA.

Impacts of Farm Policies and Technology on the Economic Viability of Southern High Plains Wheat Farms

Executive Summary

Three different size wheat farms in the Southern High Plains, representative of a majority of the commercial agriculture production for the region, were analyzed under alternative agricultural policies, federal income tax provisions, technology levels, and financial assistance programs. The purpose of this study was to quantify the impacts of the alternative policies and technology on the growth and economic viability of representative wheat farms in the Southern Plains. The farms initially operating 1280, 1920, and 3200 acres, reflected debt to asset ratios typical of farms in the area, owned the necessary machinery complement, and farmed both owned and leased cropland.

The results indicate that under the most likely technology scenario and a continuation of the provisions of the 1981 Farm Bill (Base Scenario), all three representative wheat farms will have a high probability of remaining solvent through 1992. Additionally, all three farms had a high probability of generating a reasonable return on equity and were able to grow over the 10 year planning horizon. The greatest percentage increase in average ending farm size was for the 1280 acre farm, followed by the 1920 acre operation.

Imposing an acreage reduction program (acreage set aside and paid diversion) increases net farm incomes and average net present value for all three farms. Acreage reduction programs increase average ending farm size slightly more for the 3200 acre farm than for the 1280 acre farm.

Removing the deficiency payment program (income supports) reduced the

probability of survival for only the 1920 acre farm. Although each farm suffered a reduction in average annual net farm income, the reduction was significantly greater for the 1280 acre farm. Average annual growth rates declined more for the two smaller farms.

Removing both price (CCC loan and FOR) and income supports (deficiency payments) reduced the probability of survival for both the 1280 and 1920 acre farms. All three farms experienced slower rates of growth as a result of eliminating price and income supports. Average ending farm size ranged from 19 to 16% less than under the Base. All three farms experienced negative annual net farm incomes on the average.

Removing all farm program provisions reduced the probability of survival for all three wheat farms. Probability of survival (100% under the Base) declines to 48% for the 1280 acre farm, 32% for the 1920 acre farm, and 92% for the 3200 acre farm. Average ending net worth for the farms declined over the period due to a decline in land values.

Imposing a more restrictive set of federal income tax provisions on the three representative wheat farms slowed the average annual growth rate more for the two larger farms than for the 1280 acre farm. Farm growth occurred more by leasing cropland than by purchasing land due to reduced cash reserves. The 3200 acre farm experienced the greatest absolute reduction in annual net farm income (about $20,000), followed by the 1920 acre farm.

Yield enhancing technology anticipated over the next 10 years will likely contribute to farm growth. The greatest benefit will accrue to those farms initially adopting the new technology.

A two year interest rate subsidy program would provide greater benefits to highly levered wheat farms than a debt restructure program.

Probability of survival for a highly levered 1920 acre wheat farm was increased from 40% to 80% by an interest rate subsidy.

In conclusion, the results of this study indicate that moderate-size wheat farms, 1280 to 1920 acres, in the Southern High Plains are more dependent upon farm program provisions than larger farms for their continued growth and economic viability. The loss of any farm program provision, however, negatively impacts farms of all sizes.

Impacts of Farm Policies and Technology on the Economic Viability of Southern High Plains Wheat Farms

The economic impacts of farm policy, income tax provisions, and technology have not been clearly linked to changes in farm structure (Gardner). Numerous economists have suggested that farm programs have accelerated the growth of large scale farms while other economists suggest that the link between government programs and increased farm size has never been empirically demonstrated in a *ceterus paribus* world (Quance and Tweeten; Gardner; Gardner and Pope).

The purpose of this study is to analyze the impacts of selected farm programs, federal income tax provisions, and technology on the viability of three different size wheat farms in the Southern High Plains.

Methodology

The first step in achieving the objectives of this study was to describe three different size wheat farms representative of the study area. The second step, involved a simulation of the representative farms using a Monte Carlo, whole-farm simulation model (FLIPSIM V) under alternative farm policy, income tax, finance, and technology scenarios.

Representative Farms

Results of a stratified random sample of wheat producers in Ochiltree County, Texas, obtained in 1980 by researchers at Texas A&M, were used to initially identify characteristics for representative farms in the Southern High Plains. Once three different size farms were described, county agents and farmers in the Texas High Plains were asked to review and comment on the farms as to the appropriate cropmix, machinery complement, yields, off-farm income, level of annual family consumption, use of hired labor, and crop share rental arrangement. Their suggested changes along with financial data obtained from the 1979 Farm Finance Survey and the 1982 Texas Agricultural Extension Service Enterprise Budgets for High Plains Region I were used to develop the representative farms described in this section of the report.

A 3200 acre wheat farm was developed to represent the scale of agriculture typical of the largest 10% of all wheat farms in Northern Texas, Western Kansas, Oklahoma Panhandle, and Eastern Colorado as defined in a 1979 Farm Finance Survey. A 1920 acre wheat farm was used to represent the next smaller 20 percentile; 1400-2500 acres according to the Farm Finance Survey, while a 1280 acre farm was typical of approximately 30% of the farms in the four state area.

The initial characteristics for the three representative farms are summarized in Table 1. The proportion of cropland owned by each farm was obtained from the 1979 Farm Finance Survey summarized for those wheat farmers in Western Kansas, Eastern Colorado, the Oklahoma Panhandle and the Northern High Plains of Texas who had real estate debt. Acres of pastureland owned and proportion of cropland irrigated for each farm size was obtained from the Texas A&M survey of farmers in Ochiltree County. The average value of cropland and pastureland for 1982/83 was obtained from lending institutions in the region. Beginning cash reserves for each farm were based on the 1979 Farm Finance Survey. The value of machinery for each farm was derived simply as the sum of market values for all items in the respective farm's initial machinery complement. Average values of off-farm investments reported for each farm in the 1979 Farm Finance Survey were used to complete each farm's initial assets.

Average long- and intermediate-term debt asset ratios from the Farm

Table 1. Financial Characteristics of Three Representative Wheat Farms by Size in the Southern High Plains.

Characteristics	Farm Size (acres) 1280	1920	3200
Cropland acres owned	640	840	1400
Cropland acres leased	640	1080	1800
Acres of pastureland owned	120	220	360
Value of owned cropland ($1,000)	296.0	388.5	647.5
Value of owned pastureland ($1,000)	29.4	53.9	88.2
Value of machinery ($1,000)	241.9	352.2	477.2
Value of off-farm investments ($1,000)	37.3	49.0	53.5
Beginning cash reserve ($1,000)	10.0	12.0	20.0
Long-term debt ($1,000)	60.2	86.3	143.5
Intermediate-term debt ($1,000)	83.2	126.5	171.3
Initial net worth ($1,000)	470.3	642.3	970.7
Equity ratio (fraction)[a]	0.77	0.75	0.75
Leverage ratio (fraction)[b]	0.31	0.33	0.33
Long-term debt/asset (fraction)	0.19	0.20	0.20
Intermediate term debt/asset (fraction)	0.34	0.36	0.36
Off farm income ($1,000)	12.4	9.8	9.0
Minimum family living expenses ($1,000)	18.0	20.0	23.0
Maximum family living expenses ($1,000)	40.0	50.0	50.0

[a] The equity ratio is the ratio of total net worth and total assets.

[b] Leverage ratio is the ratio of total debt to total net worth.

Finance Survey were used to estimate initial values for these debts. All three wheat farms had approximately the same beginning equity level, 0.75 (Table 1). Minimum family living expenses were based on values obtained from the Texas A&M survey of Ochiltree County farmers. Average annual off-farm income from wages and salaries was obtained from the Farm Finance Survey.

A typical cropping pattern in the High Plains is to irrigate 50% of all cropland planting half to wheat and half to grain sorghum. Wheat is generally raised on the dryland portion of the cropland. This cropping pattern was assumed for all three farms. Numerous crop share arrangements prevail in the region for leased land. These arrangements, however, typically involve the producer paying the landlord about 25% of the crop and the landlord paying none of the production and harvesting costs. This crop share arrangement was assumed for all leased cropland. All native pastureland, owned by the farm operator, was assumed to be leased out for $5/acre.

Typically farm operators in the region harvest their own irrigated sorghum and most of their irrigated wheat. Dryland wheat is predominately custom harvested, based on the Texas A&M survey of Ochiltree County farmers. The machinery complements for the three farms were developed to reflect this practice, and where necessary, were modified based on producer feed back. An initial complement for each farm was developed from the Texas A&M survey prior to soliciting comments from local producers.

The 1280 acre farm hired one, full-time farmhand while the 1920 and 3200 acre farms each employed two. Annual salaries for full time labor were estimated at $13,000 while part-time labor was available as needed for $4.32/hour.

In the simulation model, each farm was forced to buy the necessary machinery and irrigation equipment as it grew. After growing 640 acres each farm had to buy a complete machinery complement costing approximately $175,000. After growing an additional 960 acres, each farm had to buy an additional $211,000 of machinery and irrigation equipment. In this manner, growing farms continued to have machinery complements consistent with larger representative farms. The 1280 acre farm also had to hire one additional full time employee when it grew beyond 1919 acres.

Under high level management conditions, average annual yields are 50 and 15 bushels/acre for irrigated and dryland wheat, respectively (Table 2). Under similar conditions, irrigated sorghum averages 50 cwt./acre in the study area. Irrigated wheat yields have taken a dramatic increase over the past 5 years due to the introduction of a new wheat variety (TAM105). This increase in average irrigated wheat yields is reflected in the mean yields for the three farms. Average yields for irrigated wheat on representative farms in the region averaged 51 bushels/acre over the period 1974-1983 (Table 2) and after adjusting for weather (hail), yields average 60 bushels/acre after 1980. All farms were assumed to have the same variability in wheat and sorghum yields and prices based on the historical variability observed over the 1974-1983 period (Table 2).

Projected cash production expenses (excluding labor and interest) for irrigated wheat in 1982 were $2.43/bu. Similar costs for dryland wheat and irrigated sorghum were $1.16/bu. and $2.39/cwt., respectively. Out of pocket cash costs for harvesting were estimated at $12/acre for irrigated wheat, $9/acre for dryland wheat and $20.40/acre for sorghum. All three farms were assumed to have the same non-labor per acre production and harvesting costs.

Table 2. Annual Yields and Prices for Typical Wheat Farms in the Southern High Plains, 1974-1983.

Year	Irrigated Sorghum (cwt/acre)	Irrigated Wheat (bu/acre)	Non-Irrigated Wheat (bu/acre)	Wheat Price[a] ($/bu)	Sorghum Price ($/cwt)
1974	50.8	28.3	0	4.23	4.02
1975	49.4	61.4	24.0	3.90	3.97
1976	51.9	48.2	10.0	3.12	3.38
1977	48.6	54.4	15.6	1.97	3.21
1978	49.1	57.4	8.0	2.79	3.78
1979	54.3	54.0	30.9	3.83	4.12
1980	44.0	61.4	13.9	3.72	5.85
1981	49.4	60.5	12.1	3.63	4.16
1982	53.8	37.5	17.1	3.21	4.18
1983	55.0	49.5	24.0	3.30	5.01
Historical Averages	50.63	51.26	15.56	3.37	4.17

[a] Wheat prices are average August cash prices for wheat North of the Canadian River in Texas. Sorghum prices are average October cash prices for grain sorghum North of the Canadian River in Texas. Wheat and sorghum yields are per harvested acre yields of whole farms in the region.

Simulation Model

The current version of the General Firm Level Policy Simulator--FLIPSIM V (Richardson and Nixon) was used to simulate the three representative wheat farms for selected policy and technology scenarios. The model is capable of simulating the annual functions of a crop farm, i.e., production, marketing, financial growth and decay, machinery depreciation and replacement, family consumption, incurring fixed and variable costs, and participating in farm programs.

Each representative farm was simulated over the 10-year planning horizon beginning in 1983 and extending through 1992. The planning horizon was then repeated 50 times (iterations) using a different set of random wheat and sorghum prices and yields for each iteration. At the end of each iteration values for key output variables were calculated.

The model begins each year of the planning horizon by determining the production costs for the current size of the farm. The cropmix and fraction of cropland irrigated were assumed constant across different size farms.

After determining the relevant costs for the farm, the model selects the random crop prices and yields for that year. Random yields for irrigated wheat, sorghum and dryland wheat, as well as, random prices for wheat and sorghum were drawn so as to reflect the historical variability typical of the study area. Yields for actual farms in the study area were used to estimate this typical variability in yields.

Average yields are increased annually based on the technology scenario being analyzed. The most likely technology scenario for wheat and feed grains over the next 10 years was used as a base. Since not all farms adopt new technology at the same time, it was assumed the 3200 acre farm would adopt wheat related technology during years 1-6. The 1920 acre farm was assumed to adopt wheat related technology during years 7-10 and the 1280 acre farm would not adopt during the 1983-1992 planning horizon. Feed grain related technology was assumed to be adopted during years 1-5 for the 3200 acre farm and between years 6-10 for the 1920 acre farm. Prior to adoption mean yields were equal to historical averages in Table 2, however, after adoption wheat yields were held constant at 126% of their historical means. Sorghum yields were similarly increased to 105% of their historical means after adoption.

FLIPSIM V simulates variable production costs for each crop by multiplying the per acre input costs by planted acreages for the respective crops. Labor costs are calculated as the sum of full-time labor charges plus the cost of part-time labor. Part-time labor needs are based on the difference between hours of monthly labor available from full time employees and non-paid family members, and the monthly labor needs for all crops. Harvesting costs are the product of the out-of-pocket per unit harvesting costs, random yield, and harvested acreage. Each farm's initial production and harvesting costs were expressed in 1982 dollars.

The model calculates property taxes based on the price of land and the actual property tax rate for the study area. Other fixed costs are exogenously determined by the analyst. The model amortizes all outstanding loans assuming they are simple interest mortgages. Annual interest rates for existing debt on land, machinery, and operating loans were, respectively, 8.5, 13.4, and 14.4%. Annual interest rates for new debts and refinance loans long- and intermediate-term assets were 11.4 and 13.4%, respectively. Cash reserves and off-farm investments were allowed to earned 10% interest annually. The market value of farm machinery was updated assuming the real market value of used equipment decreased 1% per year. The market value of cropland was estimated using the historical relationship between the capital gains rate for cropland and the rate of returns for farms in the study area. The capital gains rate is a function of the capital gains rate for land in the previous year and the rate of return to production assets for the farm in the previous year.[1]

The model depreciates each piece of equipment on the farm for income tax purposes. Equipment purchased prior to 1981 was depreciated using the double declining balance method and a 5 to 7 year life. Equipment placed in use after 1980 was cost recovered assuming a 5 year life and the Accelerated Cost Recovery System (ACRS) rules. Regular purpose and special purpose buildings were depreciated using ACRS rules or the double declining balance method where applicable. Equipment that has passed its economic life (7 to 10 years) was replaced by trading the existing piece for a replacement. The cost of replacement equipment expressed in 1982 dollars was held constant throughout the planning horizon. First year expensing and maximum investment tax credit were calculated for all equipment purchases.

The fraction of each crop marketed in the current tax year was estimated internally based on the operator's desired taxable income ($7,400), estimated cash receipts, and income tax deductions.[2] If the market price is less than the effective loan rate for a crop, it is placed in the CCC loan when available, rather than being sold. After nine months in the CCC loan, the wheat and sorghum is moved into the farmer owned reserve (FOR). Stocks are released from the loan (or FOR) if the market price exceeds the release price. Deficiency payments are paid if the season average price is less than the target price. The deficiency payment is a function of the payment rate, farm program yield, and harvested acreage. When an acreage set aside or diversion program is simulated, the model reduces planted acreage the specified amount and accounts for increases in production on the more productive land left in production (slippage).

After simulating the farm policies specified by the user, the model determines the farm operator's year-end financial position, calculates family cash withdrawals,[3] and income taxes payable in the following year. Cash surpluses are deposited in a 10% interest bearing account. Year-end cash flow deficits are handled in the following order: (a) grant a lien on crops in storage at the operating loan interest rate, (b) refinance long-term equity, (c) refinance intermediate-term equity, (d) and/or sell cropland. If the operator is unable to cover the deficit in one of these ways, the farm is declared insolvent and the model proceeds to the next iteration after calculating the operator's accrued income and self-employment taxes.

Personal income taxes and self-employment taxes were calculated assuming the operator was married, filed a joint income tax return, and itemized personal deductions.[4] The regular income tax liability was computed using two methods: (a) income averaging (if qualified), and (b) the standard tax tables. The model selected the tax strategy which resulted in the lower income tax liability.[5]

The farm was permitted to grow at the end of each year by purchasing cropland, if the operator had cash available (after meeting all expenses) to cover a 30% downpayment for land and a 35% downpayment for any additional machinery necessary for the proposed larger farm. The operator was permitted to borrow against equity in owned land to meet up to 50% of the downpayment for land. The farm operation could also grow by leasing land if the operator had sufficient cash available to cover, when necessary, the 35% downpayment requirement for purchasing additional machinery required to operate the larger size farm. If machinery was purchased due to growth, the machinery was depreciated, investment tax credit calculated, and the operator's income taxes recomputed.

After checking the farm's prospects for growth, the model updates the farm operator's balance sheet, cash flow statement, and prepares to simulate the next year of the planning horizon. The steps in the simulation process described above are repeated for 10 years or until the farm is declared insolvent. After completing each iteration, the model summarized the information for numerous key output variables and returned the farm to its initial economic situation (year one). This insures that each farm faced the same economic, policy, and physical relationships for each of 50 iterations analyzed.

Policy and Technology Scenarios

The three representative wheat farms were simulated for 10 years under the alternative scenarios described below. Seven farm policy scenarios (including a continuation of the 1981 Farm Bill), one income tax provision scenario, two financial bailout scenarios, and three alternative technology scenarios. All assumptions and policy values associated with each scenario were held constant across farm sizes to allow direct comparison of their impacts.

Farm Policy Scenarios

1. Base Policy -- The Base Policy Scenario involves continuation of the 1981 Farm Bill through 1992 and continuation of the income tax provisions under the 1982 Tax Act (TEFRA) through 1992. Annual mean crop yields were assumed to increase based on expected adoption of new technology, as identified in the previous section. For this scenario it is assumed the following farm policies were in effect.

- CCC loan program is available for sorghum and wheat.
- A 3 year indirect farmer owned reserve (FOR) is available for sorghum and wheat.
- An acreage diversion/set aside program in effect for 1983-1985, was utilized excluding PIK. No acreage diversion/set aside program was in effect for 1986-1992.
- A target price-deficiency payment program is available for sorghum and wheat in all years.
- The $50,000 payment limitation for deficiency and diversion payments is in effect.
- Farms of all sizes are eligible to participate in these farm program provisions.

Values for loan rates, target prices, diversion rates, and diversion payment rates for 1983, 1984 and 1985 are set at their actual values in terms of 1982 dollars. Loan rates and target prices for 1986/1992 are held constant at their 1985 levels. Annual loan rates and target prices used in the analysis are summarized in Table 3 for 1983-1992. Historical farm policy parameters for Southern High Plains farms are outlined in Table 4. The average relationship between real loan rates and real prices for 1977-1982 were used to determine the real average annual prices for wheat and sorghum in 1983-1992. (This was done to minimize any bias created by setting mean prices too close to either the loan rate or the target price.)

It was assumed the following options for depreciating machinery and

Table 3. Localized Loan Rates and Target Prices for Wheat and Sorghum in the Southern High Plains, 1983-1992.[a]

	Sorghum		Wheat	
Years	Loan Rates	Target Prices	Loan Rates	Target Prices
	- - - ($/cwt) - - -		- - - ($/bu) - - -	
1983	4.386	4.757	3.557	3.948
1984	4.107	4.886	3.137	4.088
1985	4.008	4.768	3.062	4.063
1986	4.008	4.768	3.062	4.063
1987	4.008	4.768	3.062	4.063
1988	4.008	4.768	3.062	4.063
1989	4.008	4.768	3.062	4.063
1990	4.008	4.768	3.062	4.063
1991	4.008	4.768	3.062	4.063
1992	4.008	4.768	3.062	4.063

[a] All values are expressed in 1982 dollars.

Table 4. Loan Rates, Target Prices, and Acreage Set Aside/Diversion Levels for Wheat and Sorghum, 1977-1985.

Year	Loan Rate	Target Price	Set Aside Rate	Diversion Rate	Diversion Payment Rate
		- - - - - wheat - - - - -			
	($/bu)	($/bu)	(%)	(%)	($/bu)
1977	2.25	2.90			
1978	2.35	3.40			
1979	2.50	3.40			
1980	3.30	3.63			
1981	3.50	3.81			
1982	4.00[a]	4.05	15.0	0.0	---
1983	3.65	4.30	15.0	5.0	2.70
1984	3.30	4.38	20.0	10.0	2.70
1985	3.30	4.38	20.0	10.0	2.70
		- - - - - sorghum - - - - -			
	($/cwt)	($/cwt)	(%)	(%)	($/cwt)
1977	3.39	4.07			
1978	3.39	4.07			
1979	3.57	4.18			
1980	3.82	4.46			
1981	4.07	4.55			
1982	4.32	4.64	10.0	0.0	2.54
1983	4.50	4.88	10.0	10.0	2.54
1984	4.32	5.14	0.0	0.0	0.00
1985	4.32	5.14	20.0	7.5	2.54

[a] Farmer Owned Reserve entry price in 1982 exceeded the $3.55/bu loan rate for wheat.

calculating income taxes are used for the Base scenario.

- Machinery and buildings placed in use prior to 1981 are depreciated using the double declining balance method.
- Machinery and buildings placed in use after 1980 are depreciated using an accelerated cost recovery method.
- The operator elects to claim first year expensing for all depreciable items.
- The operator elects to take maximum investment tax credit (ITC) and reduce the basis.
- The operator adjusts crop sales across tax years to reduce current year taxes.
- The operator may use either the regular income tax computation or income averaging to calculate federal income tax liabilities.
- There is no maximum interest deduction for calculating taxable income.
- The actual self employment tax rates and maximum income levels subject to this tax for 1983 and 1984 are used. Announced values for these variables in 1985-1986 were used and the 1986 values were held constant through 1992.
- The operator elects to trade-in old machinery on new replacements at the end of each item's economic life.

II. A 20% Acreage Reduction -- The provisions of the Base Policy Scenario were modified by adding a 15% set aside with a 5% diversion for sorghum and wheat in 1986-1992. Reasonable slippage (70% for wheat and sorghum) and program participation rates were used to estimate the resulting increase in mean prices for these crops in 1986-1992.[6] All other provisions of the Base Scenario were used without change.

III. No Farm Program Payment Limitation -- All provisions of the Base Scenario were used except there was no limitation on diversion and deficiency payments.

IV. No Price and Income Supports -- The CCC loan, FOR, and target price provisions under the Base Scenario were assumed to have been eliminated for all years in the planning horizon (1983-1992). Annual mean prices for all crops were decreased based on the expected impact of removing the price and income support programs. Relative variability in prices was increased based on the work of Morton, Devadoss, and Heady as to the effects of no farm program on U.S. agriculture.[7] To isolate the impact of the price and income supports on the representative farms, the paid diversion and set aside programs in the Base were assumed to remain in effect.

V. No Target Price/Deficiency Payment -- The target price and deficiency payment program was assumed to be eliminated for all years of the planning horizon (1983-1992). All other provisions of the Base Scenario were used without change to isolate the effects of only removing the deficiency payment program.

VI. Target Farm Program Benefits -- All farm program and income tax provisions of the Base Scenario were used except that farms with more than $300,000 of sales were not eligible to participate in farm program provisions. This program restriction excluded the 3200 acre farm from participating directly in the program provisions (CCC loan, FOR, target price/deficiency payments, and diversion payments). Mean prices and relative variability in prices were not adjusted because sufficient "small" farms were assumed to participate in the farm program for the price support actions of the CCC loan and FOR to function normally.

VII. No Farm Program -- All farm program provisions outlined for the

Base Scenario were eliminated for all 10 years of the planning horizon. Mean annual prices and relative variance in prices for the No Price and Income Supports Scenario (IV) were used due to eliminating provisions of the CCC loan and FOR reserve under this scenario.

Income Tax Scenarios

VIII. Reduced Income Tax Benefits and Base Farm Program -- The federal income tax provisions in place for the Base Policy Scenario were made more restrictive. All farm policy provisions of the Base Scenario were left unchanged. The more restrictive federal income tax provisions included:

- Machinery and buildings were depreciated using the straight line cost recovery method.
- First year expensing provisions were eliminated for all depreciable items.
- Investment tax credit (ITC) provisions were continued but the maximum ITC provision was eliminated.
- The maximum annual interest expense which could be used to reduce taxable income was $15,600. This value represents the annual interest expense deductions a consumer might have for a home, automobiles, etc.
- The operator must sell obsolete machinery upon disposition rather than trading it in on new replacements, thus forcing recapture of excess depreciation deductions.

All other federal income tax provisions for the Base Scenario were used as outlined earlier.

Financial Stress Scenarios

IX. Base Finance Scenario -- Each farm's long-term debt to asset ratio was increased to 0.55 and its intermediate-term debt to asset ratio was increased to 0.60 to represent a highly leveraged farm. Annual long- and intermediate-term interest rates were increased to their average values for 1980-1983 (.1139 and .1343, respectively) to represent a farm which had been forced to refinance its assets during the past four years. The farm program provisions associated with the Base Policy Scenario (I) are continued for this scenario.

X. Debt Restructure -- The length of intermediate-term loans was increased by 1 year and a portion of intermediate debt was converted to long-term debt. The conversion of intermediate-term debt was permitted as long as the long-term debt to asset ratio did not exceed 0.65. For some farms, this allowed all intermediate-term debt to be converted to long-term debt while for other farms this constraint substantially restricted debt conversion. Total debt loads and farm program provisions were the same as those used for the Base Finance Scenario (IX).

XI. Interest Subsidy -- The annual interest rates, debt levels, and farm program provisions in the Base Finance Scenario (IX) were simulated with the exception of an interest subsidy provided during the first two years. The interest subsidy took the form of an interest rate reduction equal to 3.4 percentage points for long-term interest rates and 5.4 percentage points for intermediate-term interest rates. These interest rate reductions were the amounts necessary to reduce their respective interest rates (.1137 and .1343) to 8%.

Technology Scenarios

XII. No New Technology and Base Farm Policy -- The federal income tax and farm program provisions in the Base Policy Scenario (I) were simulated assuming no increase in mean yields over the planning horizon. For the No

New Technology Scenarios annual mean yields were fixed in all years at the values in Table 2 for all three representative farms.

XIII. No New Technology and No Deficiency Payments -- The farm program provisions in the No Target Price/Deficiency Payments Scenario (V) were simulated assuming no change in annual mean crop yields.

XIV. No New Technology and No Farm Program -- All farm program provisions were eliminated (Scenario VIII) and annual average crop yields were assumed to remain constant over time.

Evaluation Criterion

The FLIPSIM V model provides considerable detail as to the viability of a representative farm at the end of each iteration, e.g., ending leverage ratio, ending net worth, ending farm size, total assets, total debt, net present value, and whether the farm remained solvent for 10 years. By repeating each scenario for 50 iterations, the model generates the information necessary to estimate probability distributions for key output variables. The means of these key output distributions are used to compare the economic impacts of selected policy and technology scenarios on representative farms. The following output variables for the model were selected to compare the impacts of the scenarios described in the previous section.

- *Probability of survival* is defined as the probability that the representative farm will remain solvent for 10 years. In other words, it is the probability that the farm operator would maintain, for all 10 years of the planning horizon, at least the minimum financial ratios required by bankers in the local area, i.e., debt to asset ratios less than 0.70.
- *Probability of a positive net present value* is the probability that the

representative farm will have a positive after-tax net present value. An after-tax, real discount rate of 3% was used to calculate the farm's net present value. Thus this statistic indicates the probability of the representative farm providing at least a 3% real rate of return to the operator's initial net worth.

- *After-tax net present value (NPV)* is the present value of the operator's annual cash withdrawals (CW) plus the present value of the change in net worth (NW) minus the present value of annual off-farm income (OY):

  $$NPV = \sum_{t=1}^{T} \frac{CW_t - OY_t}{(1.03)^t} + \frac{NW_T}{(1.03)^T} - NW_o$$

  Cash withdrawals equal family living expenses plus state and federal income taxes and self-employment taxes. Initial net worth (NW_o) and ending net worth (NW_T) include the value of off-farm investments and accrued taxes. A 3% after-tax, real discount rate was used to calculate net present value for all representative farms.

- *Present value of ending net worth* is used to indicate the change in the farms real net worth over the planning horizon. Net worth is affected by increases (or decreases) in asset (land, machinery, and livestock) value and retained earnings. This value can be compared directly to initial net worth (Table 1) to indicate the relative magnitude of real financial growth.

- *Acres owned, leased, and controlled* at the end of the planning horizon for each iteration indicate the impacts of alternative scenarios on the rate of growth for representative farms. These three statistics provide an indication of how the farm grew either by purchasing or leasing land. Also, they indicate whether the farm was forced to sell cropland to remain solvent.

- *Total long- and intermediate-term debts* at the end of the planning horizon provide an insight into the financial stress of the farm over the planning horizon. Increases in average ending debt from one scenario to another can be due to either rapid growth through purchasing land and machinery or the farm operator being forced to refinance large cash flow deficits. When surplus cash is available, the operator is permitted to prepay intermediate-term debts and new long-term debts. Therefore large ending intermediate-term debts indicate insufficient cash was available to reduce intermediate-term debt through prepayment of principal.
- *Ending equity ratio* is the ratio of total net worth to total assets at the end of each iteration. This ratio provides a "bottom-line" measure for comparing the representative farm's ending financial position across scenarios.
- *Average Annual Net Farm Income* is the average net farm income received by the operator over all years simulated. Net farm income equals total farm receipts plus total government payments minus all cash production expenses, interest payments, labor costs, fixed costs (excluding principal payments), and depreciation. This value excludes all non-farm income and interest earned on cash reserves.
- *Average Annual Government Payments* is the average government payment (deficiency and diversion payments) received over all years simulated.

Table 5. Comparison of Selected Policy Secenarios on a Representative 1280 Acre High Plains Wheat Farm.

Criteria	Initial Situation	Alternative Scenarios[a] I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	--	100	100	100	76	100	100	48	100
Probability of Positive Net Present Value (%)	--	100	100	100	20	50	96	10	100
After-tax net present value mean ($1,000)	--	427.3	691.8	436.1	-136.9	11.4	387.6	-236.6	341.1
Average present value of ending net worth ($1,000)	470.3	803.0	1032.3	811.1	282.8	425.7	761.3	189.0	709.9
Average ending cropland owned (acres)	640.0	995.2	1052.8	995.2	755.2	748.0	969.6	681.6	822.4
Average ending cropland leased (acres)	640.0	905.6	902.4	905.6	809.6	864.0	940.8	796.8	934.4
Average ending cropland controlled (acres)	1280.0	1900.8	1955.2	1900.8	1564.8	1648.0	1910.4	1478.4	1756.8
Average ending long-term debts ($1,000)	60.2	122.4	94.8	117.9	198.9	170.6	142.4	177.5	80.0
Average ending intermediate-term debts ($1,000)	83.2	40.4	24.0	39.8	152.3	78.0	53.3	193.7	35.4
Average ending equity ratio (fraction)	0.77	0.84	0.88	0.84	0.46	0.67	0.81	0.35	0.87
Average internal rate of return (fraction)	--	0.09	0.12	0.09	-0.04	0.02	0.08	-0.09	0.09
Average annual net farm income ($1,000)	--	2.6	18.3	3.1	-33.6	-21.4	-0.9	-41.6	-8.3
Average annual gov't payment ($1,000)	--	30.9	31.5	31.6	2.5	2.5	27.7	0.0	29.4

[a] The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program

Table 6. Comparison of Selected Policy Seccnarios on a Representative 1920 Acre High Plains Wheat Farm.

Criteria	Initial Situation	Alternative Scenarios[a] I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	--	100	100	100	50	90	96	32	100
Probability of Positive Net Present Value (%)	--	100	100	100	12	34	76	6	100
After-tax net present value mean ($1,000)	--	519.8	894.8	622.9	-265.8	-74.2	159.6	-393.0	369.2
Average present value of ending net worth ($1,000)	642.3	1028.1	1359.4	1117.4	294.4	474.6	695.8	178.7	833.1
Average ending cropland owned (acres)	840.0	1233.6	1352.0	1227.2	955.2	1048.0	1144.0	862.4	1067.2
Average ending cropland leased (acres)	1080.0	1531.2	1537.6	1528.0	1278.4	1291.2	1473.6	1230.4	1432.0
Average ending cropland controlled (acres)	1920.0	2764.8	2889.6	2755.2	2233.6	2339.2	2617.6	2092.8	2499.0
Average ending long-term debts ($1,000)	86.3	167.0	134.6	114.5	289.9	315.9	275.5	250.9	203.6
Average ending intermediate-term debts ($1,000)	126.5	21.9	37.7	19.0	265.9	179.9	87.1	318.5	66.4
Average ending equity ratio (fraction)	0.75	0.86	0.88	0.89	0.35	0.53	0.69	0.24	0.77
Average internal rate of return (fraction)	--	0.09	0.12	0.10	-0.08	0.00	0.04	-0.18	0.08
Average annual net farm income ($1,000)	--	9.0	28.5	17.3	-52.5	-34.9	-17.6	-67.9	-21.8
Average annual gov't payments ($1,000)	--	39.0	39.1	44.7	4.2	3.7	16.2	0.0	37.3

[a] The scenarios are:

I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program

Table 7. Comparison of Selected Policy Secenarios on a Representative 3200 Acre High Plains Wheat Farm.

Criteria	Initial Situation	Alternative Scenarios[a] I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	--	100	100	100	100	100	100	92	100
Probability of Positive Net Present Value (%)	--	100	100	100	88	100	92	66	100
After-tax net present value mean ($1,000)	--	1241.2	1530.5	1642.0	278.2	628.6	249.2	89.7	1154.3
Average present value of ending net worth ($1,000)	970.7	1936.1	2203.7	2230.6	1096.4	1412.4	1086.7	925.1	1657.1
Average ending cropland owned (acres)	1400.0	1912.0	1960.0	2094.4	1521.6	1678.4	1499.2	1486.4	1611.2
Average ending cropland leased (acres)	1800.0	2305.6	2404.8	2388.8	2030.4	2155.2	1995.2	1985.6	2193.6
Average ending cropland controlled (acres)	3200.0	4217.6	4364.8	4483.2	3552.0	3833.6	3494.4	3472.0	3804.8
Average ending long-term debts ($1,000)	143.5	108.5	113.2	109.9	183.4	130.6	196.5	262.2	94.8
Average intermediate-term debts ($1,000)	171.3	28.8	23.1	9.4	138.8	85.4	130.8	175.9	26.5
Average ending equity ratio (fraction)	0.75	0.92	0.92	0.91	0.80	0.88	0.80	0.70	0.90
Average internal rate of return (fraction)	--	0.11	0.13	0.14	0.05	0.08	0.05	0.03	0.12
Average annual net farm income ($1,000)	--	48.9	59.5	78.4	-7.8	15.6	-13.6	-25.1	28.1
Average annual gov't payments ($1,000)	--	44.2	45.0	76.9	5.8	5.9	0.0	0.0	44.1

[a] The scenarios are:

I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program

Results

The results of simulating Scenarios I-VIII for the three representative wheat farms are summarized in Tables 5-7. Under the Base Policy Scenario, all three farms had a 100% chance of remaining solvent for 10 years and an equal chance of receiving a positive net present value. All three farms were able to substantially increase their real net worth on the average and all three experienced increases in their average equity to asset ratio. In addition, all three farms were able to increase the average total acres farmed by 1992. The 1280 acre farm grew an average of 49%, while the 1920 and 3200 acre farms grew 44 and 32%, respectively.

Acreage Reduction Program

Imposing a 20% acreage reduction program (Scenario II) increased the three representative farm's average net present value, average ending net worth, and average ending farm size. These results were expected because acreage reduction programs increase the mean price of wheat and sorghum and provide a limited diversion payment to offset part of the costs for diverting land. The increase in mean price reduced the deficiency payment rate, however average deficiency payments were increased slightly (less than 2%) due to increased average ending farm size. The average ending farm size for the smaller farm was 2.9% greater than the Base while the larger farms grew an average of 4% over the Base.

No Payment Limitation

Eliminating the $50,000 payment limitation (Scenario II) resulted in substantial increases in average annual government payments for the 3200 acre wheat farm. The 1280 acre wheat farm had virtually no increase in government payments and the 1920 acre farm had only a $5,700 increase in payments. Average net farm income for the 3200 acre farm increased about $30,000 (or 60%) while the 1280 acre farm had no increase in net farm income. The 3200 acre farm had a 6.3% increase in average ending farm size due to removing the $50,000 payment limitation. The two smaller farms did not increase their average ending acreage controlled as a result of removing the payment limitation.

No Price and Income Supports

Removing both price and income supports (Scenario IV) did not reduce the probability of survival for the 3200 acre farm, however it reduced the probability of survival 50 percentage points for the 1920 acre farm, and 24 percentage points for the 1280 acre farm. The probability of receiving a positive net present value declined 12, 88 and 80 percentage points for the 3200, 1920, and 1280 acre farm, respectively. Average annual net farm income for the 1280 acre farm declined from $2,600 under the Base to -$33,600, while average net present value declined by 132%. In contrast, the 3200 acre farm experienced a decline in net farm income from $48,900 to -$7,800, and a 78% decline in average net present value.

Compared to the Base Scenario, the average ending farm size under Scenario IV was 17.6%, 19.2%, and 15.8% lower for the 1280, 1920, and 3200 acre farms, respectively. The results suggest large-scale farms with 75% or greater equity should be able to withstand increased price variability better than smaller farms, thus making smaller farms more dependent on price and income support farm programs. All farm sizes, however, suffer significant negative impacts when income and price supports are removed.

No Income Supports

Removing the target price/deficiency payment Scenario (V) reduced the probability of survival and the probability of receiving a positive net present value for the 1920 acre farm more than the other two farms. Average ending farm size for the 1920 acre farm was 15.4% less than the Base, while average ending farm size fell 13.3% for the 1280 acre farm and 9.1% for the 3200 acre farm. The loss in deficiency payments reduced average annual government payments $38,300 for the largest farm and $28,400 for the 1280 acre farm. On a per acre basis, this reduction in government payments was 300% greater for the 1200 acre farm than the 3200 acre farm.

Target Farm Program Benefits

If farm program provisions were to be targetted to farms producing $300,000 or less (Scenario VI), the largest wheat farm would be precluded from participating directly in the farm program in all years. The two smaller farms would be able to participate in the farm program until they grew beyond the $300,000 threshold. The elimination of government payments for the 3200 acre farm resulted in a 44% decrease in average ending net worth and a 17% decline in average ending farm size, relative to the Base. The 1280 acre farm experienced a 10% decrease in its average annual government payments and the 1920 acre farm showed a 58.5% decrease. Average net present value declined 9, 69, and 80% for the 1280, 1920, and 3200 acre farms, respectively. These results indicate that targetting farm program benefits accomplished its objective in reducing the rate of growth for large-scale wheat farms while not affecting the rate of growth for small and moderate-size (1280 acre) farms.

Under Scenario VI (target farm program benefits) the 3200 acre farm did not experience a decrease in its probability of survival as it did when all farm program benefits are removed (Scenario VII). The reason being that this farm benefitted indirectly from reduced price variability resulting from smaller farms participating in the CCC loan and FOR.

No Farm Program

Removing all farm program benefits (Scenario VII) reduced the probability of survival for all three representative wheat farms. The probability of survival fell from 100% under the Base to 48, 32, and 92% for the 1280, 1920, and 3200 acre farms, respectively. The 3200 acre farm was able to maintain a strong survival probability due primarily to a strong initial financial position. Average ending net worth was less than initial net worth for all three farms. The three farms experienced negative average annual net farm incomes ranging from -$67,000 to -$25,000. As a result, the farms grew less than under the Base, although all three farms continued to grow by purchasing and leasing cropland. The 3200 acre farm grew 17.6% less than under the Base while the 1280 and 1920 acre farms grew 22 and 24.3%, respectively.

More Restrictive Income Taxes

Imposing a more restrictive set of federal income tax provisions (Scenario VIII) reduced average ending net worth, average net present value, and average ending farm size for all three farms. Probability of survival was not reduced from the Base for the representative farms. As expected, less favorable income tax provisions reduced the propensity of farms to grow through purchasing cropland in favor of growing through leasing land. The two larger farms experienced an average 9.7% decrease in average ending farm size from the Base while the 1280 acre farm had an 8% decline. The greatest decine in average net present value was for the 1920 acre farm while the smallest decline was for the 3200 acre farm. This same pattern was also observed for the decline in average annual net farm income.

Financial Bailout Strategies

To analyze the effects of alternative financial bailout strategies, the financial positions for the three representative farms were modified to approximate highly levered farms. These modified wheat farms were simulated under the Base Policy Scenario, and with two alternative financial bailout strategies. The long-term debt to asset ratio for each farm was increased to 55%, the intermediate-term debt to assets ratios were increased to 68%, and annual interest rates were increased to their average values for 1980-1983 (11.37% for long term and 13.4% for intermediate term), and off-farm assets were set equal to zero. The results of these analyses are summarized in Tables 8-10.

The 3200 acre wheat farm had a 100% chance of remaining solvent for 10 years under all three high initial debt scenarios. Under the Base no financial bailout Scenario (IX), the 1920 acre farm had only a 40% chance of remaining solvent for 10 years while the 1280 acre farm had an 86% chance of surviving. The 1920 acre farm faced greater costs of production than the other two farms because it is at the breaking point where an additional hired hand must be employed and an additional complement of machinery has been added. Thus the 1920 acre farm is more representative of a rapidly growing, highly leveraged wheat farm than either of the other two farms.

A debt restructuring bailout strategy (Scenario X) increased the probability of the 1920 acre farm remaining solvent to 70% and increased average net present value $98,500 (from -$15,800 to $82,700) (Table 9). Due to restructuring the 1920 acre farm's debt, average ending equity ratio for the farm increased from 0.29 to 0.42, although average annual

Table 8. Comparison of Selected Financial Bailout Scenarios for a Representative 1280 Acre High Plains Wheat Farm.

Criteria	Initial High Debt Situation	Alternative Scenarios[a] IX	X	XI
Probability of Survival (%)	--	86	98	100
Probability of Positive Net Present Value (%)	--	78	94	98
After-tax net present value mean ($1,000)	--	91.7	173.4	190.4
Average present value of ending net worth ($1,000)	252.3	288.9	407.6	382.7
Average ending cropland owned (acres)	640.0	662.7	700.8	678.4
Average ending cropland leased (acres)	640.0	770.8	848.0	873.6
Average ending cropland controlled (acres)	1280.0	1433.6	1548.8	1552.0
Average ending long-term debts ($1,000)	178.9	293.4	300.3	267.3
Average intermediate-term debts ($1,000)	145.2	151.7	95.8	91.9
Average ending equity ratio (fraction)	0.44	0.44	0.56	0.57
Average internal rate of return (fraction)	--	0.05	0.07	0.08
Average annual net farm income ($1,000)	--	-22.5	-21.2	-14.3
Average annual gov't payment ($1,000)	--	25.2	26.4	26.8

IX Base Finance Scenario consists of the Base farm program provisions for a highly leveraged farm

X Restructure debt for a highly leveraged farm

XI Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

Table 9. Comparison of Selected Financial Bailout Scenarios for a Representative 1920 Acre High Plains Wheat Farm.

Criteria	Initial High Debt Situation	Alternative Scenarios[a] IX	X	XI
Probability of Survival (%)	--	40	70	80
Probability of Positive Net Present Value (%)	--	40	68	78
After-tax net present value mean ($1,000)	--	-15.8	82.7	147.0
Average present value of ending net worth ($1,000)	351.4	258.2	398.8	405.6
Average ending cropland owned (acres)	840.0	868.8	865.6	878.4
Average ending cropland leased (acres)	1080.0	1124.8	1192.0	1240.0
Average ending cropland controlled (acres)	1920.0	1993.6	2057.6	2118.4
Average ending long-term debts ($1,000)	243.3	387.4	395.7	388.2
Average intermediate-term debts ($1,000)	211.3	286.7	230.1	203.8
Average ending equity ratio (fraction)	0.44	0.29	0.42	0.44
Average internal rate of return (fraction)	--	-0.02	0.02	0.04
Average annual net farm income ($1,000)	--	-37.9	-35.1	-24.1
Average annual gov't payment ($1,000)	--	34.8	35.2	35.6

IX Base Finance Scenario consists of the Base farm program provisions for a highly leveraged farm

X Restructure debt for a highly leveraged farm

XI Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

Table 10. Comparison of Selected Financial Bailout Scenarios for a Representative 3200 Acre High Plains Wheat Farm.

Criteria	Initial High Debt Situation	Alternative Scenarios[a] IX	X	XI
Probability of Survival (%)	--	100	100	100
Probability of Positive Net Present Value (%)	--	100	100	100
After-tax net present value mean ($1,000)	--	893.2	973.5	1016.2
Average present value of ending net worth ($1,000)	540.9	1248.3	1372.7	1348.2
Average ending cropland owned (acres)	1400.0	1646.4	1745.6	1697.6
Average ending cropland leased (acres)	1800.0	2132.8	2232.0	2193.6
Average ending cropland controlled (acres)	3200.0	3779.2	3977.6	3891.2
Average ending long-term debts ($1,000)	404.6	565.9	620.7	515.6
Average intermediate-term debts ($1,000)	286.3	61.5	73.7	53.8
Average ending equity ratio (fraction)	0.44	0.70	0.70	0.73
Average internal rate of return (fraction)	--	0.14	0.13	0.14
Average annual net farm income ($1,000)	--	17.1	12.4	27.5
Average annual gov't payment ($1,000)	--	43.9	44.1	44.0

IX Base Finance Scenario consists of the Base farm program provisions for a highly leveraged farm

X Restructure debt for a highly leveraged farm

XI Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

net farm income increased less than $3,000.

A two-year interest buydown program (Scenario XI) increased the probability of the 1920 acre farm remaining solvent to 80% and increased average net present value about $163,000. Average annual net farm income was increased about $13,800 over the Base. Average ending farm size was increased 6% over the Base and 10% over the initial farm size of 1920 acres. Similar effects were observed for the 1280 acre farm. For both of the smaller farms, the interest buydown bailout strategy provided more benefits than the debt restructure strategy. Both restructure and interest subsidies, however, offered significant positive benefits to the highly levered smaller farms.

No New Technology

The simulation results presented above assumed the most likely technology scenario for the 10-year planning horizon. For comparison, three policy scenarios (I, V, and VII) were analyzed assuming no new technology was adopted by the three representative farms. The results of these analyses are summarized in Tables 11-13. To evaluate the impacts of technology on the different size farms, one must compare the no new technology results in Tables 11-13 to their respective results in Tables 5-7.

Due to its immediate adoption of new technology the 3200 acre wheat farm benefitted more from the new technology than the other two farms. The 3200 acre farm experienced the greatest absolute ($897,800) and percentage (361%) increase in average net present value from adopting new technology, given the current farm program (Scenario I vs. XII). The 1920 farm had a 208% increase in average net present value under the Base Scenario while the 1280 acre farm had a 126% increase in net present value. These results are consistent with the assumptions made regarding adoption of new technology; the very-large farm adopts first, followed by the large farm, which is followed by the moderate size farm. These results also hold for the no target price Scenario (V vs. XIII) and the no farm program (Scenario VII vs. XIV).

Average annual net farm incomes are substantially enhanced by the early adoption of new technology. Under the Base farm program, the 3200 acre farm had a $51,000 increase in average annual net farm income due to adopting new technology. The increase in average annual net farm income due to new technology was about $20,000 for the 1920 acre farm and only about $4,000 for the 1280 acre farm under the Base Policy Scenario. The increases in average annual net farm incomes due to technology were generally greater for these farms under the no farm program (VII vs. XIV) and the no deficiency payment (V vs. XIII) scenarios.

Adoption of new technology for wheat and feed grains increased average ending farm size for all three farms under all three policy scenarios. The increase in average ending farm size over the no new technology scenario was generally greatest under the current farm program (Scenarios I vs. XII). About half of the growth for the 3200 acre farm, under each policy scenario analyzed, was due to the early adoption of new technology. The proportion of farm growth due to the adoption of new technology was substantilly less for the 1280 and 1920 acre farms. About 32% of the growth by the 1920 acre farm was due to new technology while only 7% of farm growth for the 1280 acre farm was due to new technology. These results indicate that farm programs had greater impacts on average ending farm size than new technology and that early adopters benefit more than those who adopt technology later.

Table 11. Comparison of Selected Farm Policy Scenarios Assuming No New Technology Scenario for a 1280 Acre High Plains Wheat Farm.

Criteria	Initial Farm	Alternative Scenarios[a] XII	XIII	XIV
Probability of Survival (%)	--	100	90	32
Probability of Positive Net Present Value (%)	--	100	26	6
After-tax net present value mean ($1,000)	--	339.5	-89.3	-292.8
Average present value of ending net worth ($1,000)	470.3	725.8	325.4	134.3
Average ending cropland owned (acres)	640.0	956.8	774.4	668.8
Average ending cropland leased (acres)	640.0	902.4	857.6	761.6
Average ending cropland controlled (acres)	1280.0	1859.2	1632.0	1430.4
Average ending long-term debts ($1,000)	60.2	119.4	199.3	178.7
Average ending intermediate-term debts ($1,000)	83.2	38.9	129.7	218.3
Average ending equity ratio (fraction)	0.77	0.84	0.53	0.25
Average internal rate of return (fraction)	--	0.08	-0.01	-0.15
Average annual net farm income ($1,000)	--	-1.3	-28.9	-46.8
Average annual gov't payments ($1,000)	--	30.7	2.5	0.0

[a] XII -- Base Policy, continuation of 1981 Farm Bill, assuming most likely yields.
XIII -- No Target Price/Deficiency payments assuming most likely yields.
XIV -- No Farm Program assuming most likely yields.

Table 12. Comparison of Selected Farm Policy Scenarios Assuming No New Technology Scenario for a 1920 Acre High Plains Wheat Farm.

Criteria	Initial Farm	Alternative Scenarios[a] XII	XIII	XIV
Probability of Survival (%)	--	100	44	10
Probability of Positive Net Present Value (%)	--	98	12	2
After-tax net present value mean ($1,000)	--	250.2	-324.4	-495.2
Average present value of ending net worth ($1,000)	642.3	779.9	228.9	81.3
Average ending cropland owned (acres)	840.0	1150.4	984.0	856.0
Average ending cropland leased (acres)	1080.0	1454.4	1320.0	1192.0
Average ending cropland controlled (acres)	1920.0	2604.8	2304.0	2048.0
Average ending long-term debts ($1,000)	86.3	242.8	316.3	247.9
Average ending intermediate-term debts ($1,000)	126.3	55.2	310.5	362.9
Average ending equity ratio (fraction)	0.75	0.76	0.27	0.11
Average internal rate of return (fraction)	--	0.06	-0.13	-0.27
Average annual net farm income ($1,000)	--	-10.9	-52.9	-77.1
Average annual gov't payments ($1,000)	--	38.1	3.9	0.0

[a] XII -- Base Policy, continuation of 1981 Farm Bill, assuming most likely yields.
XIII -- No Target Price/Deficiency payments assuming most likely yields.
XIV -- No Farm Program assuming most likely yields.

Table 13. Comparison of Selected Farm Policy Scenarios Assuming No New Technology Scenario for a 3200 Acre High Plains Wheat Farm.

Criteria	Initial Farm	Alternative Scenarios[a] XII	XIII	XIV
Probability of Survival (%)	--	100	82	28
Probability of Positive Net Present Value (%)	--	94	22	6
After-tax net present value mean ($1,000)	--	343.6	-260.4	-644.9
Average present value of ending net worth ($1,000)	970.7	1130.9	561.9	219.9
Average ending cropland owned (acres)	1400.0	1672.0	1528.0	1412.8
Average ending cropland leased (acres)	1800.0	2027.2	2014.4	1908.8
Average ending cropland controlled (acres)	3200.0	3699.2	3542.4	3321.6
Average ending long-term debts ($1,000)	143.5	280.8	432.7	391.8
Average ending intermediate-term debts ($1,000)	171.3	78.5	292.6	453.3
Average ending equity ratio (fraction)	0.75	0.78	0.47	0.20
Average internal rate of return (fraction)	--	0.05	-0.02	-0.18
Average annual net farm income ($1,000)	--	-2.1	-45.4	-85.8
Average annual gov't payments ($1,000)	--	43.7	5.9	0.0

[a] XII -- Base Policy, continuation of 1981 Farm Bill, assuming most likely yields.
XIII -- No Target Price/Deficiency payments assuming most likely yields.
XIV -- No Farm Program assuming most likely yields.

Summary of Results

Base Policy Scenario

- All three representative farms had a 100% chance of remaining solvent through the 10 year planning horizon.
- All three farms had a 100% chance of having a positive net present value.
- On the average, all three farms were able to grow by purchasing and leasing cropland.
- The greatest percentage increase in ending farm size was for the 1280 acre farm (48%) and the smallest increase was for the 3200 acre farm (32%).

Acreage Reduction Programs

- Average net present value was increased for all three farms as a result of an acreage reduction program.
- A 20% acreage reduction program increased average ending farm size 2.8% for the 1280 acre farm and 3.5% for the 3200 acre farm.
- Average ending equity ratios for the two smaller farms were increased 2 percentage points by a 20% acreage reduction program.
- Average annual net farm incomes for the 1280 and 1920 acre farms were increased more than twice as much as for the 3200 acre farm.
- Although average deficiency payment rates were reduced, average annual deficiency payments were increased slightly (less than $1,000) due to greater average ending farm size.

No Payment Limitation

- The larger the farm, the greater the impacts on farm growth and income from removing the $50,000 payment limitation on deficiency and diversion payments. Average net present value increased 32% for the 3200 acre farm, 20% for the 1920 acre farm, and only 2% for the 1280 acre farm.
- Removing the payment limitation increased the average ending farm size 6.3% for the 3200 acre farm while not affecting average ending farm size for the two smaller farms.

No Price Supports and No Deficiency Payments

- Removing price and income supports for wheat and sorghum reduced the probability of survival for the 1280 and 1920 acre farms while not affecting the 3200 acre farm's probability of survival. The probability of survival for the 1920 acre farm declined the most, 50 percentage points.
- Average net present value was reduced 132% for the 1280 acre farm, 151% for the 1920 acre farm, and 78% for the 3200 acre farm.
- Average ending farm size was reduced from the Base scenario for all three farms. The 1280 acre farm controlled an average of 17% fewer

acres, the 1920 acre farm controlled 19% fewer acres, and the 3200 acre farm controlled 16% fewer acres.

- Loss of price and income supports reduced average annual net farm incomes to less than zero for all three farms.
- The presence of an effective $50,000 payment limitation causes the income support program to benefit the 1280 acre farm relatively more than the 3200 acre farm. In contrast, the price support program benefits the 3200 acre farm relatively more than the 1280 acre farm.

No Target Price/Deficiency Payments

- Eliminating deficiency payments reduced the probability of survival more for the 1920 acre farm than for the 3200 acre farm. The 1920 acre farm's probability of receiving a positive net present value also decreased more for the 1920 acre farm than for the larger farm.
- The $50,000 payment limitation, if effective, reduced the current benefits of the deficiency payment for the 3200 acre farm, so its loss reduced average ending farm size less than the two smaller farms.
- The loss of deficienty payments reduced the average net present value of smaller farms more than twice as much as for the 3200 acre farm.
- Average ending farm size was reduced more in percentage terms for the smaller farms (-13.3% and -15.4%) than for the 3200 acre farm (-9%) if deficiency payments are removed.

Target Farm Program Benefits to Small Farms

- The 3200 acre farm was prevented from participating directly in the various farm program provisions in all years. As the 1280 and 1920 acre farm grew beyond the $300,000 threshold, they were similarly excluded from direct farm program provisions.
- The 3200 acre and 1920 acre farms experienced greater absolute and percentage declines in average net present value and average ending farm size than the 1280 acre farm. Average ending farm size for the 3200 acre farm declined 17% while the 1280 acre farm did not decrease its average ending farm size.
- Although the 3200 acre farm was unable to participate directly in the price support program, it benefited indirectly from the price stabilization effect of the loan and FOR.

No Farm Program

- Removing all farm program provisions reduced the 1280 and 1920 acre farm's chances of survival to 48% and 32%, respectively, while reducing the 3200 acre farms chance of survival to 92%.
- The percentage reduction in average net present value was similarly reduced more for the 1280 and 1920 acre farms than the 3200 acre farm.
- In the absence of farm programs, all three farms continue to grow but at a much slower rate than under the Base program. The 3200 acre farm grew about 17% less than the Base while the 1280 and 1920 acre farms grew 22 and 24%, respectively, less than the Base.
- The reduction in land values, due to removing farm program benefits,

resulted in all three farms experiencing losses in net worth over the planning horizon.

More Restrictive Federal Income Tax Provisions

- More restrictive federal income tax provisions reduced the average annual rate of growth more for the two larger farms than for the 1280 acre farm.
- Increasing the federal income tax burden on farmers reduced their propensity to grow through purchasing cropland relative to leasing.
- Probability of survival and probability of receiving a positive net present value were not affected by more restrictive income tax provisions.
- All three farms experienced reductions in average annual net farm income. The 3200 acre farm experienced the greatest absolute reduction in net farm income $20,000, followed by the 1920 acre farm.

Financial Bailout Strategies

- Restructuring debt for highly levered wheat farms provided a substantial benefit to the three farms. Average net present value and the probability of survival for all three farms was raised due to a debt restructuring program.
- An interest rate buy-down strategy increased the probability of survival more than the debt restructure strategy. For the most disadvantaged farm, this strategy doubled the probability of survival, going from 40% to 80%.

Impact of Technology

- Early adopters experienced greater annual growth rates than later adopters. New technology accounted for none of the 1280 acre farm's growth while it accounted for 50% of the 3200 acre farm's growth, under the Base farm program.
- Farm programs had a greater effect on average ending farm size for the 1280 and 1920 acre farms than new technology. New technology accounted for 50% of 3200 acre farm's growth under the Base program and 65% of the farm's growth under the no farm program scenario.

Footnotes

[1] The annual capital gain rate for cropland (cgrate) is calculated as a function of the lagged capital gain rate and the real rate of return to production assets (rret) in the previous period:

$$\mathrm{cgrate} = \underset{(-1.37)}{-0.0559} + \underset{(1.76)}{0.0582}\ \mathrm{Dummy} + \underset{(1.73)}{0.3673}\ \mathrm{cgrate}_{t-1} + \underset{(3.46)}{2.490}\ \mathrm{rret}_{t-1}$$

The Dummy variable is one for 1979 and 1980 and zero otherwise and the student -t ratios are below their respective coefficients. The R square for this equation was 68.6% and the F ratio was 6.55. The coefficients were estimated using national capital gain rates for farmland (USDA, *Farm Real Estate Market Developments)* and national residual returns to farm assets as a percent of total assets (pages 105-106, USDA, *Economic Indicators)*.

[2] Income tax consequences frequently determine the fraction of crops sold during the income tax year they are harvested. The first step in calculating this fraction is to determine the operator's expected income tax deductions and cash receipts. Estimated deductions include: fixed costs, interest payments, variable production and harvesting costs, labor costs, depreciation, crop insurance premiums, and personal income deductions ($1,000 per dependent plus excess itemized deductions). Estimated cash receipts include: value of all crops if sold in the current tax year; value of crops held over from the previous year and sold in the current year; all off-farm income; and other farm income. If estimated cash receipts are less than estimated tax deductions plus the targeted taxable income ($7,400), all crop production is sold in the current tax year. When cash receipts exceed deductions plus $7,400, the proportion

of crops sold in the next tax year equals the percentage of the crop that must be carried over for current cash receipts to equal deductions plus $7,400.

[3] A linear family consumption function was assumed for wheat farmers in the Texas Northern High Plains. The function assumed a minimum level of annual family living expenses was incurred regardless of the farm's financial condition. Beyond the minimum, the operator had a 0.25 marginal propensity to consume out of disposible income. The consumption function was bounded on the top side by a maximum level of annual family living expenses (Table 1).

[4] Depreciation recapture, capital gains and losses, investment tax credit, and depreciation allowances are explicitly accounted for in calculating the sole proprietor's accrued income tax liability. If there is a net operating loss from prior years, taxable income in the current year is appropriately reduced. If there is a net operating loss in the current year it is automatically carried forward. Net operating loss carryback is not permitted in the model.

[5] All investment tax credit allowances were deducted from the regular tax liability and the result was compared to the income tax liability under the alternative minimum tax. The operator paid the excess of the alternative minimum tax over the sum of the regular income tax liability and the regular minimum tax. Income tax rate schedules for 1983 and 1984 were included in the model, as well as a procedure to develop tax rate schedules for 1985-1992 based on changes in the Consumer Price Index.

[6] The price response from a 15% acreage set-aside and 5% diversion for

wheat was calculated assuming the own price flexibility for wheat of -1.50, slippage of 70%, and program participation of 60%. Based on these assumptions the price response would be about 5.4%, so the annual mean wheat prices in Table 3 were increased 5.4% in 1986-1992. The price response from a 15% acreage set-aside and 5% diversion for sorghum was calculated assuming a -1.75 price flexibility for feed grains with 30% slippage and 40% participation by feed grain producers. Based on these assumptions the price response would be about 9.8% and annual sorghum prices in Table 3 were increased 9.8% in 1986-1992.

[7] Morton, Devadoss, and Heady estimated the effect of removing all farm programs on wheat and corn. Their results suggest that the relative variability in the price of wheat and corn would increase 207% and 131%, respectively, and the mean prices for these crops would decline 1% and 8%. One would expect that removing price supports (CCC loan and FOR) increased the variability of wheat price more than corn because price support mechanisms have influenced the season average price of wheat more frequently than the corn price over the past decade. Deviates about mean prices for wheat (in Table 3) were multiplied by 2.07 to reflect the increased price variability Morton, Devadoss, and Heady estimated would occur without farm programs. Similarly, deviates about mean sorghum prices were multiplied by 1.31 for the no price support and no farm program scenarios.

The annual mean prices for wheat were reduced about 5% and sorghum prices were reduced about 2% to reflect the effect of no price supports on mean prices. These decreases in mean prices were estimated by calculating mean sorghum and wheat prices for 1983 using the empirical distributions in Table 3, both with and without the price supports.

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Background Paper No. 5

Economic Impacts of Selected Farm Policies, Income Tax Provisions, and Production Technology on the Economic Viability of Corn-Soybean Farms in East Central Illinois and Irrigated Row Crop Farms in South Central Nebraska

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Introduction

The purpose of this study is to analyze the impacts of selected farm programs, federal income tax provisions, and production technologies on the economic viability of representative "commercial" farms in the corn-soybean cash-grain area of East Central Illinois and in the irrigated row-crop area of South Central Nebraska. It is also expected that the results will apply in broad principle to the major feed grain-soybean production area of the North Central Region. The results are, however, mainly illustrative because few, if any, actual farms correspond exactly to the representative farms which were simulated. Thus the relative results for the several farm sizes and for the several alternative policy scenarios considered are probably more important than any specific numbers generated by the analysis.

Method of Analysis

The objectives of this study were met by a two-step procedure. The first step involved describing representative farms of three different sizes in each of the two type-of-farming areas. The second step involved simulating these representative farms using a Monte Carlo, whole-farm simulation model (FLIPSIM V) under alternative farm policy, income tax and production technology scenarios. The simulation model is described by James Richardson elsewhere in this report.

Representative Farms

The representative farm situations developed and utilized in this analysis were constructed from two basic data sources: (1) national cost-of-production surveys conducted by the Economic Research Service of USDA in 1978 and 1983, and (2) farm record data collected and analyzed by the Universities of Illinois and Nebraska. Data from these sources were augmented with financial information from USDA's 1979 Agricultural Finance Survey.

As a general procedure, the size of representative farms and the acreages of owned and rented cropland were developed from the size distributions in the USDA cost-of-production surveys. The "very large" farms approximate the largest 10 percent of farms in the surveys, the "large" farms the 70th to 90th size percentiles and the "medium" farms the 40th to 70th percentiles.

In actual practice the financial status of farmers, as measured by net worth, debt load (both intermediate and long-term) and leverage ratio, differs dramatically from farmer to farmer. We have adapted data from the 1979 Agricultural Finance Survey to depict the beginning financial characteristics for the six representative farms analyzed here (Tables 1A and 1B). This shows the "large" and "very large" Illinois representative farms to be somewhat more highly leveraged (indebted) than the other farm units. But, there are a number of farmers in both production areas who are now in more precarious financial condition than is true for any of the representative farms depicted here. And, there are also some farmers who are debt free or virtually so. Later on in this report we increase and standardize the degree of financial leverage for all six representative farms and analyze the effects of selected financial "bailout" policies on their survivability.

All of the representative farms analyzed here are well mechanized production units ranging from 640 to 2085 acres of cropland and all farms include a combination of owned and rented land. Of the six representative farms, only the "very large" units in each area employ full-time hired workers. The other farms operate with a combination of family and part-time workers. The Illinois farms have all of their cropland devoted to cash crop production of corn and soybeans. The Nebraska farms are cash crop operations which combine both gravity and sprinkler technologies to irrigate corn and a small acreage of soybeans. In addition they produce a substantial acreage of

TABLE 1A: Financial Characteristics of Three Representative Corn-Soybean Farms in East Central Illinois[a]

	Farm Size		
	Medium	Large	Very Large
Cropland Acres	640	982	1630
Acres Owned	260	429	458
Acres Leased	380	553	1172
Value of Owned Real Estate (1,000)[b]	900.5	1480.6	1538.4
Value of Machinery ($1,000)	92.2	104.8	129.0
Long-term Debt ($1,000)	126.1	557.4	579.2
Intermediate-term Debt ($1,000)	55.3	62.9	83.8
Initial Net Worth ($1,000)[c]	855.4	1027.6	1106.4
Leverage Ratio (fraction)	0.21	0.61	0.60
Long-term Debt/Asset (fraction)	0.14	0.38	0.38
Intermediate-term Debt/Asset (fraction)	0.60	0.60	0.65
Equity Ratio (fraction)	0.82	0.62	0.63
Off Farm Income ($1,000)	8.2	7.4	7.6
Minimum Family Living Expenses ($1,000)	18.0	20.0	24.0
Maximum Family Living Expenses ($1,000)	36.0	40.0	48.0
Marginal Propensity to Consume (fraction)	0.20	0.20	0.20

[a] A family size of 4 persons was assumed for the purposes of estimating family labor supply and determining appropriate income tax rates.

[b] Includes land and buildings.

[c] May include assets other than land, buildings and machinery.

TABLE 1B: Financial Characteristics of Three Representative Irrigated Corn Farms in South Central Nebraska[a]

	Farm Size		
	Medium	Large	Very Large
Cropland Acres	672	920	2085
Acres Owned	302	530	1042
Acres Leased	370	390	1043
Value of Owned Real Estate ($1,000)[b]	477.7	838.4	1648.3
Value of Machinery ($1,000)	102.7	112.1	183.9
Long-term Debt ($1,000)	123.2	102.0	291.1
Intermediate-term Debt ($1,000)	40.1	53.7	98.0
Initial Net Worth ($1,000)[c]	448.3	839.0	1463.1
Leverage Ratio (fraction)	0.39	0.20	0.27
Long-term Debt/Asset (fraction)	0.26	0.12	0.18
Intermediate-term Debt/Asset (fraction)	0.39	0.48	0.53
Equity Ratio (fraction)	0.72	0.84	0.79
Off Farm Income ($1,000)	8.2	8.2	9.7
Minimum Family Living Expenses ($1,000)	18.0	18.0	24.0
Maximum Family Living Expenses ($1,000)	36.0	36.0	48.0
Marginal Propensity to Consume (fraction)	0.20	0.20	0.20

[a] A family size of 4 persons was assumed for the purposes of estimating family labor supply and determining appropriate income tax rates.

[b] Includes land and buildings.

[c] May include assets other than land, buildings and machinery.

grain sorghum under a non-irrigated (dryland) regime. Production on this dryland acreage tends to be somewhat riskier than for the irrigated component of their farming operations. But irrigated farming still has some year-to-year yield variability due to weather and disease and insect infestations. Although a number of these irrigated corn farms also produce some wheat and/or corn silage we have not included those enterprises for the representative farms considered here.

The crop mix for the Nebraska farms is identical for all three farm sizes: irrigated corn (58.3 percent of cropland acres); irrigated soybeans (6 percent); dryland sorghum (35.7 percent). On the Illinois farms, the proportion of corn to soybeans varies only slightly for the three representative farms with corn planted on from 52 to 55 percent of the cropland acreage and soybeans on the balance.

For the Illinois farms, all cropland has the same per-acre value while the price of cropland on the Nebraska farms reflects the differentials for four categories of land: (1) gravity irrigated, (2) sprinkler irrigated, (3) dryland with irrigation potential, (4) dryland without irrigation potential. Each of the three Nebraska farms do, however, have the same proportions of gravity irrigation, sprinkler irrigation and dryland acres.

The financial data included in Tables 1A and 1B (including land values) are for a 1982 base year. All other costs and values presented for subsequent years are also in 1982 prices. Thus the major decline in land prices which has occurred since 1982 is consistent with the low farm earnings shown in the "results" section of this report.

Minimum and maximum family living expenses are also shown in Tables 1A and 1B and range between $18 thousand per year (minimum) and $48 thousand (maximum) depending on location and on the size of the farm business.

Crop Yields and Prices

Historical yields and prices for the two crops included in the analysis for Illinois (dryland corn and soybeans) and the three crops for Nebraska (irrigated corn and soybeans and dryland sorghum) are shown in Table 2. There is a good deal of variability in all yields and prices with the greatest variability shown for dryland sorghum yields.

Mean commodity prices used in the simulation analysis are shown in Table 3. The year-to-year increases in grain yields for the period to 1992 are those expected to occur under an assumption of "most likely" technology. The simulation analysis did, however, assume a differential rate in the adoption of new technology between the three different sizes of farm units. The "very large" farms were assumed to adopt new technology most rapidly and the medium-size farms most slowly. The expected outcome with "no new technology" will be considered in a later section of this report.

The simulation analysis was stochastic, and, the actual yields and prices were drawn randomly (by the simulation model) from a sample of yields and prices which included variability proportionate to that present in the historical (1973-82) data. Yield-price correlation matrices are shown in Tables 4A and 4B for the Illinois and Nebraska situations respectively.

Policy and Technology Scenarios

The six representative farms were each simulated over the 10-year period (1983-92) for a total of seventeen alternative scenarios. These included the eight alternative farm program-income tax provision scenarios, three financial stress scenarios (with "financial bailout" alternatives), three "no new technology" scenarios and three scenarios to evaluate the economic status for "new entrants" into farming.

TABLE 2: Annual Yields and Prices for Illinois and Nebraska Production Regions 1974-82*

Year	Illinois Corn	Illinois Soybeans	Nebraska Corn (Irrigated)	Nebraska Soybeans (Irrigated)	Nebraska Sorghum
			---------- yields in bushels per acre ----------		
1973	118.1	38.1	114.9	34.3	63.5
1974	89.8	26.2	118.3	33.9	34.1
1975	134.6	42.0	123.9	36.1	39.2
1976	132.4	37.9	126.3	42.3	42.4
1977	98.3	42.7	124.2	40.1	69.1
1978	122.8	40.0	130.5	38.8	64.1
1979	137.5	43.0	138.3	42.7	78.8
1980	84.1	37.2	113.4	41.7	60.3
1981	132.4	39.5	140.9	44.4	72.8
1982	143.9	43.5	130.0	42.2	69.6
			---------- prices in dollars per bushel ----------		
1973	2.65	5.85	2.41	5.37	2.09
1974	3.04	6.50	2.88	6.10	2.68
1975	2.58	5.13	2.46	4.77	2.26
1976	2.16	7.07	2.02	6.40	1.78
1977	2.11	6.05	1.97	5.65	1.74
1978	2.31	6.75	2.30	6.41	1.94
1979	2.59	6.47	2.48	5.81	2.27
1980	3.15	7.62	3.05	7.09	2.79
1981	2.55	6.16	2.54	5.64	2.26
1982	2.71	5.76	2.44	5.27	2.16

* Illinois yields are averages for Dewitt, McLean and Tazewell Counties. Illinois prices are for the Central District. Nebraska yields are averages for Buffalo, Kearney and Phelps Counties. Nebraska prices are for the Southern District.

TABLE 3: Mean Prices Used for Simulations for Illinois and Nebraska Farms

Year	Illinois Corn	Illinois Soybeans	Nebraska Corn (Irrigated)	Nebraska Soybeans (Irrigated)	Nebraska Sorghum
	------------ prices in dollars per bushel*				
1983	3.00	6.75	2.81	6.30	2.74
1984	2.82	6.58	2.64	6.13	2.56
1985	2.75	6.42	2.57	5.97	2.50
1986	2.75	6.42	2.57	5.97	2.50
1987	2.75	6.42	2.57	5.97	2.50
1988	2.75	6.42	2.57	5.97	2.50
1989	2.75	6.42	2.57	5.97	2.50
1990	3.75	6.42	2.57	5.97	2.50
1991	2.75	6.42	2.57	5.97	2.50
1992	2.75	6.42	2.57	5.97	2.50

---

* The "mean" prices presented here for 1985-92 are "planning prices" which bear the same expected relationship to announced 1985 commodity loan rates as was true for the relationship between "realized prices" and "loan rates" during the period 1977 to 1983.

TABLE 4A: Correlation Matrix of Yields and Prices for the Illinois Corn-Soybean Farms*

	Yields		Prices	
	Corn (bushels)	Soybeans	Corn	Soybeans
Corn	1.0	0.573	-.036	-.037
Soybeans		1.0	-.102	.083
Corn			1.00	.033
Soybeans				1.0

* The correlation matrix was estimated using deviations about a simple OLS trend line for annual yields and prices, 1974-1983. Prices were deflated to a base of 1982=100 using the Index of Prices Paid by Farmers, prior to fitting the trend line.

TABLE 4B: Correlation Matrix of Yields and Prices for the Nebraska Irrigated Corn Farms*

	Yields			Prices		
	Corn	Soybeans	Sorghum	Corn	Soybeans	Sorghum
Corn	1.0	.388	.248	-.442	-.379	-.413
Soybeans		1.0	.102	-.716	-.095	-.662
Sorghum			1.0	-.224	-.098	-.316
Corn				1.0	.142	.982
Soybeans					1.0	.083
Sorghum						1.0

* The correlation matrix was estimated using deviations about a simple OLS trend line for annual yields and prices, 1974-1983. Prices were deflated to a base of 1982=100 using the Index of Prices Paid by Farmers, prior to fitting the trend line.

Scenario I is a base policy situation to which alternative policy options are compared. This base policy scenario involves continuation of the 1981 farm bill through 1992 and continuation of the income tax provisions under TEFRA for the same period. As indicated earlier, crop yields are those consistent with "most likely" expected production technology. Values for loan rates, target prices, acreage diversion rates and diversion payment rates for 1983 and 1984 are set at their actual values expressed in 1982 dollars. For subsequent years, the values for these same variables are set at their announced levels for 1985 and then held constant through 1992.

Evaluation Criteria

The evaluation criteria used in the simulation of Illinois and Nebraska farms are the same as those described by Richardson elsewhere in this report and identified briefly in the tables which follow. They include:

(1) probabilities for economic survival (solvency) through the 10-year planning period (1983-92) and for a positive return (net present value) at the end of the period,

(2) the present values for average end-of-period net worth and for after-tax net present value,

(3) growth in the farm business over the 10-year period as measured by the ending inventory of cropland owned and rented,

(4) long-term and intermediate-term debts and equity ratios at the end of the 10-year period,

(5) profitability of investment as measured by internal rate of return,

(6) average annual net farm income, and

(7) average annual government payments received

Separately and in combination these evaluative criteria trace the impacts of alternative policy scenarios on several key dimensions of economic well-being for each of the six representative farms.

Results For Alternative Farm Policy Scenarios

A. The Illinois Farms

Results of the simulations for the three Illinois corn-soybean farms for each of the eight farm policy and income tax scenarios are presented in Tables 5-7. Changes from the base scenario (Scenario I) are summarized in Table 8 for selected measures of farm size, wealth and financial characteristics. A summary of the major implications for each of the three farms is presented in the sections which follow.

1. The Medium Size (640-acre) Farm:

The probability of economic survival for this farm remains at 100 percent for all but two of the eight scenarios simulated (Table 5). These are the scenarios with no price support and deficiency payments (Scenario IV) and with no farm programs (Scenario VII). But, other measures of economic well-being differ rather dramatically among the other alternatives. Even with a continuation of the farm programs specified in the 1981 farm bill, the probability for this farm realizing a positive net present value over ten years is only 38% (Scenario I). Moreover, over the 10-year planning period (1983-92) the farm business loses an expected $152 thousand in net worth as measured on a "present value" basis. Of the expected average annual net farm income of $23,200, about 50% ($11,600) comes from government payments. In the base scenario, cropland controlled grows over 10 years by more than 40 percent as a result of increasing long-term debt to purchase additional land (115 acres) and leasing additional land (147 acres). Since this representative farm is not excessively debt burdened at the outset it is possible to grow in size by purchasing additional cropland and still maintain a healthy ending equity ratio of 0.76. And, excessively low equity ratios are not a problem

TABLE 5: Comparison of Selected Policy Scenarios on a Representative Medium Size (640-Acre) Corn-Soybean Farm in East Central Illinois

Criteria	Initial Situation	Alternative Scenarios a/ I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	---	100	100	100	100	100	100	100	100
Probability of Positive After-Tax Net Present Value (%)	---	38	64	38	12	6	26	6	58
After-Tax net present value mean ($1,000)	---	-4.8	50.9	-4.8	-170.5	-141.4	-50.2	-172.1	32.2
Average present value of ending net worth ($1,000)	855.4	703.4	742.6	703.4	568.4	593.3	669.2	563.3	719.2
Average ending cropland owned (acres)	260.0	375.2	400.8	375.2	306.4	309.6	348.0	296.8	391.2
Average ending cropland leased (acres)	380.0	527.2	503.2	527.2	517.6	527.2	559.2	536.8	501.6
Average ending cropland controlled (acres)	640.0	902.4	904.0	902.4	824.0	836.8	907.2	833.6	892.8
Average ending long-term debts ($1,000)	126.1	259.6	274.2	259.7	168.4	168.9	212.9	153.9	251.7
Average ending intermediate-term debts ($1,000)	55.3	10.4	6.4	10.4	27.8	26.1	9.9	31.7	5.3
Average ending equity ratio (fraction)	0.82	0.76	0.76	0.76	0.79	0.79	0.79	0.79	0.77
Average internal rate of return (fraction)	---	0.03	0.04	0.03	0.01	0.01	0.03	0.01	0.04
Average annual net farm income ($1,000)	---	23.2	29.9	23.2	10.2	11.8	19.1	11.1	19.0
Average annual total government payments ($1,000)	---	11.6	9.8	11.6	0.7	0.7	8.6	0.0	11.7

a/ The scenarios are:

I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II — A 20% Acreage Reduction in 1986-1992.
III — No Farm Program Payment Limitation in 1983-1992.
IV — No Price Support and No Deficiency Payment in 1983-1992.
V — No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII — Reduced Income Tax Benefits and the Base Farm Program.

for any of the policy scenarios considered. In short, aside from the decline in net worth, the base scenario (continuation of 1981 farm act programs) represents a rather satisfactory economic situation for the 640-acre corn-soybean farm. And, of the alternative policy scenarios considered, only Scenario II (which adds set aside and diversion payments along with a 20 percent acreage reduction) results in a better economic situation.

Elimination of price and income supports (Scenario IV) or even elimination of target prices and deficiency payments (Scenario V) results in a dramatic deterioration in all measures of economic well-being compared to the base scenario. Targeting farm program benefits to farms producing less than $300,000 in program crops (Scenario VI) results in only modest economic loss as compared to a continuation of 1981 programs. This occurs because expected growth in cropland pushes gross income beyond $300,000 and all commodity sales are from program crops. Lower cut-off levels for program benefits would, of course, have proportionately greater negative impacts.

Reducing the income tax benefits available to farmers (Scenario VIII) does not have significant economic implications for the 640-acre Illinois farm. If fact, except for a decline in average net income of about $4,200 per year, other measures of economic well-being under this scenario are improved slightly from those realized with the base situation.

In summary, the economic status of the 640-acre farm deteriorates dramatically with (1) the removal of all price and income supports, and (2) with the removal of target prices and deficiency payments only. But it is little affected by the targeting of farm program benefits to farms with sales of $300,000 or less in program crops or by a reduction in income tax benefits of the type considered here.

With available production technology, the potential for size expansion is great for this 640-acre farm. Although cropland purchases drop substantially under the several scenarios which eliminate or greatly modify existing farm programs (Scenarios IV, V and VII), cropland operated is increased under all scenarios by a minimum of 28% (Table 8). Moreover, the ending equity ratio remains strong in all scenarios.

2. The Large (982-acre) Farm:

The results for the eight simulations of alternative policy scenarios for the 982-acre farm are shown in Table 6. These results follow the same general pattern as for the 640-acre farm with some notable exceptions.

First, as shown in Table 1A, this representative farm has a relatively higher initial leverage ratio and lower total equity ratio (0.62). And, the latter ratio drops below this level for three of the scenarios considered. In no case, however, does it drop below 0.55.

Second, the loss of farm program benefits is much more costly than for the 640-acre farm because for the base scenario (continuation of 1981 Farm Act programs), government payments make up about 93% of the farms average annual net farm income. As a result, the loss of government price and income supports is rather devastating for this 982-acre farm. Moreover, targeting farm program benefits to farms with $300,000 or less in the sale of program crops (Scenario VI) has a major economic impact on this farm which has expected sales of well over $300,000 in program crops even without additional growth in farm size.

For this farm unit, it is profitable to grow by purchasing land only when major governmental farm program assistance is available (Scenarios I, II and III). Even then the amounts of land purchased are only about 100 acres. Faced with heavy long-term debt, most expansion in farm size can only be

TABLE 6: Comparison of Selected Policy Scenarios on a Representative Large Size (982-Acre) Corn-Soybean Farm in East Central Illinois

Criteria	Initial Situation	Alternative Scenarios a/ I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	---	100	100	100	100	100	100	100	100
Probability of Positive After-Tax Net Present Value (%)	---	84	74	84	6	4	24	4	80
After-Tax net present value mean ($1,000)	---	131.1	116.6	152.0	-259.9	-201.6	-82.9	-281.9	130.1
Average present value of ending net worth ($1,000)	1027.6	974.9	969.5	990.9	644.6	693.2	800.7	622.2	851.8
Average ending cropland owned (acres)	429.0	537.8	528.2	550.6	432.0	454.6	456.2	431.6	443.4
Average ending cropland leased (acres)	553.0	836.2	836.2	837.8	706.8	725.8	898.6	702.4	773.8
Average ending cropland controlled (acres)	982.0	1374.0	1364.4	1388.4	1138.8	1180.4	1354.8	1134.0	1217.2
Average ending long-term debts ($1,000)	557.4	689.1	65[illegible].6	707.8	506.5	543.7	551.6	505.4	530.1
Average ending intermediate-term debts ($1,000)	62.9	42.2	38.7	49.2	126.9	118.4	74.6	137.1	53.5
Average ending equity ratio (fraction)	0.62	0.62	0.64	0.61	0.57	0.73	0.63	0.55	0.65
Average internal rate of return (fraction)	---	0.05	0.05	0.06	0.01	0.02	0.03	0.00	0.06
Average annual net farm income ($1,000)	---	24.3	22.9	26.4	14.3	5.2	8.0	1.1	24.9
Average annual total government payments ($1,000)	---	22.6	16.6	24.3	1.0	1.0	7.8	0.0	21.9

a/ The scenarios are:

I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

accomplished via leasing.

Although the probability of firm survival continues at 100% for all eight policy scenarios, the probability of realizing a positive after-tax net present value drops to 6% or less for the three scenarios in which government price and income supports are reduced in a major way. Moreover, the mean value for this criterion averages about -$375 thousand for these three scenarios and the internal rate of return is 2% or less. All of these measures are indicative of a highly unprofitable farm business in the absence of strong support in the form of government programs.

3. The Very Large (1630-acre) Farm:

Results for the eight alternative policy scenario simulations for the 1630-acre farm are shown in Table 7. The generally more favorable economic situation for this farm than for the 982-acre farm is due largely to the utilization of a much larger acreage of rented land on the "very large" farm. As a result, although the total debt loads and leverage ratios are almost the same for these two representative farms, the largest farm initially controls 648 acres more of cropland. Thus, with large debts and high interest rates impairing the profits on owned cropland, the operation of additional rented land eases the average per acre burden of land costs. As a result, this very large farm has a 100% probability of survival for all eight of the policy scenarios evaluated.

The 1630-acre farm is already a very large farm. Substantial expansion beyond this size requires major machinery investment with borrowed money. It also requires hiring more full-time labor. As a result, the profitable growth in cropland acreage for the base scenario (19%) is proportionately smaller than for the 640-acre farm (41%) and the 982-acre farm (40%). And, although the loss of price and income supports and of current income tax benefits

TABLE 7: Comparison of Selected Policy Scenarios on a Representative Very Large Size (1630-Acre) Corn-Soybean Farm in East Central Illinois

Criteria	Initial Situation	Alternative Scenarios a/							
		I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	---	100	100	100	100	100	100	100	100
Probability of Positive After-Tax Net Present Value (%)	---	98	98	98	66	78	86	76	98
After-Tax net present value mean ($1,000)	---	478.5	597.9	478.7	138.4	-192.7	220.7	198.4	461.2
Average present value of ending net worth ($1,000)	1106.4	1266.8	1348.0	1265.6	991.0	1032.9	1056.1	1036.0	1043.9
Average ending cropland owned (acres)	458.0	726.8	755.6	718.8	600.4	621.2	624.4	597.2	526.8
Average ending cropland leased (acres)	1172.0	1218.4	1176.8	1223.2	1255.2	1237.6	1284.0	1279.2	1256.8
Average ending cropland controlled (acres)	1630.0	1945.2	1932.4	1942.0	1855.6	1858.8	1908.4	1876.4	1783.6
Average ending long-term debts ($1,000)	579.2	848.7	871.8	846.9	697.7	726.5	703.1	659.3	586.1
Average ending intermediate-term debts ($1,000)	83.8	88.1	88.4	72.8	133.9	124.3	117.6	101.7	81.2
Average ending equity ratio (fraction)	0.63	0.62	0.61	0.63	0.60	0.61	0.62	0.63	0.56
Average internal rate of return (fraction)	---	0.07	0.08	0.07	0.04	0.05	0.05	0.05	0.08
Average annual net farm income ($1,000)	---	51.8	62.2	52.4	31.1	35.1	34.7	34.8	54.4
Average annual total government payments ($1,000)	---	23.6	19.3	25.3	1.7	1.7	0.0	0.0	23.3

a/ The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

(Scenarios IV, V, VII and VIII) result in much reduced economic returns as compared to the base scenario, the reductions are proportionately less than for the 640- and 982-acre farms. The negative impact of targeting program benefits to farms with $300,000 or less in program crops (Scenario VI) is, however, greater than for the smaller farms.

4. A Comparison Between Farms:

A summary of rates of change in selected farm size, wealth and financial characteristics under alternative policy scenarios is presented in Table 8 for all three Illinois farms. This table illustrates again the extensive deterioration in economic well-being (compared to the current situation) for all three representative farms that is associated with a loss in government price and income supports. It also illustrates the particular vulnerability of the heavily leveraged 982-acre farm to a loss in government program benefits and the reduced propensity (compared to the smaller farms) for the 1630-acre farm to grow much beyond its current size under the alternative policy scenarios considered here. There are, of course, other possible programs to assist farmers. And, two alternatives for financial "bailout" are evaluated in later sections of this report.

Finally, the reductions in net worth for all three farms and for all eight policy scenarios (as compared to the initial situation in 1982) illustrates the fact that farm real estate values were grossly overvalued in the early 1980s and vulnerable to a major decline whenever the "growth and inflation" psychology of the 1970s subsided.

TABLE 8: Rates of Change in Selected Farm Size, Wealth and Financial Characteristics For Alternative Policy Scenarios for Representative Corn-Soybean Farms in East Central Illinois

Criteria	Initial Situation	Percentage Change in Variable Level From Initial Situation For Alternative Scenarios a/							
		I	II	III	IV	V	VI	VII	VIII
					640-Acre Farm				
Present value of ending net worth ($1,000)	855.4	-18	-13	-18	-34	-31	-22	-34	-16
Cropland owned after 10 years (acres)	260.0	+44	+54	+44	+18	+19	+34	+14	+50
Cropland leased after 10 years (acres)	380.0	+39	+39	+32	+39	+36	+39	+47	+41
Total cropland controlled after 10 years (acres)	640.0	+41	+41	+41	+29	+31	+42	+30	+40
Total long-term debts after 10 years ($1,000)	126.1	+106	+117	+106	+33	+34	+70	+22	+100
Total intermediate-term debts after 10 years ($1,000)	55.3	-81	-88	-81	-50	-53	-82	-43	-90
Total equity to asset ratio after 10 years (%) b/	82.0	76	76	76	79	79	79	79	77

Criteria	Initial Situation	I	II	III	IV	V	VI	VII	VIII
					982-Acre Farm				
Present value of ending net worth ($1,000)	1027.6	-5	-6	-4	-37	-33	-22	-39	-17
Cropland owned after 10 years (acres)	429.0	+25	+23	+28	+1	+6	+6	+6	+3
Cropland leased after 10 years (acres)	553.0	+51	+51	+52	+28	+31	+62	+27	+40
Total cropland controlled after 10 years (acres)	982.0	+40	+39	+41	+16	+20	+38	+15	+24
Total long-term debts after 10 years ($1,000)	557.4	+24	+17	+27	-9	-2	-1	-9	-5
Total intermediate-term debts after 10 years ($1,000)	62.9	-33	-38	-22	+102	+88	+19	+118	-15
Total equity to asset ratio after 10 years (%) b/	62.0	62	64	61	57	73	63	55	65

Criteria	Initial Situation	I	II	III	IV	V	VI	VII	VIII
					1630-Acre Farm				
Present value of ending net worth ($1,000)	1106.4	+14	+22	+14	-10	-7	-5	-6	-6
Cropland owned after 10 years (acres)	458.0	+59	+65	+57	+31	+36	+36	+30	+15
Cropland leased after 10 years (acres)	1172.0	+4	0	+4	+7	+6	+10	+9	+7
Total cropland controlled after 10 years (acres)	1630.0	+19	+19	+19	+14	+14	+17	+15	+9
Total long-term debts after 10 years ($1,000)	579.2	+47	+51	+46	+20	+25	+21	+14	+1
Total intermediate-term debts after 10 years ($1,000)	83.8	+5	+5	-13	+60	+48	+40	+21	-3
Total equity to asset ratio after 10 years (%) b/	63.0	62	61	63	60	61	62	63	56

a/ The scenarios are:

I — Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II — A 20% Acreage Reduction in 1986-1992.
III — No Farm Program Payment Limitation in 1983-1992.
IV — No Price Support and No Deficiency Payment in 1983-1992.
V — No Target Price/Deficiency Payment in 1983-1992.
VI — Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII — No Farm Program in 1983-1992.
VIII — Reduced Income Tax Benefits and the Base Farm Program.

b/ Values for all policy scenarios represent the percent equity in total assets after 10 years, not the percentage changes in these equity to asset ratios.

B. The Nebraska Farms

Results of the simulations for the three Nebraska irrigated row-crop farms for each of the ten farm policy and income tax scenarios are presented in Table 9-11. Changes from the base scenario (Scenario I) are summarized in Table 12 for the same selected measures of farm size, wealth and financial characteristics which were presented in Table 8 for the Illinois farms.

1. The Medium Size (672-acre) Farm:

The initial net worth position for this farm is the smallest for any of the six representative farms in Nebraska and Illinois. But, with a high beginning equity ratio of 0.72, the probability of survival for this 672-acre farm remains at 100 percent for six of the eight policy scenarios and 90 percent or more for the other two (Table 9). The farming operation for this medium-size farm is economically successful for all scenarios in which basic government price and income support programs are retained (Scenarios I, II, III, VI and VIII). Average annual net farm income ranges between $26,800 and $31,000 for these scenarios and ending net present value ranges between $424,800 and $501,100. Moreover, the ending net worth climbs by from 40 to 64 percent from its initial value (Table 12). Loss of major farm program benefits, on the other hand, produce losses in net worth of more than 40% for the no price and income supports and the no farm program scenarios (Scenarios IV and VII). And, the probability of positive after-tax net present values for the latter two scenarios drops to around 30%. Although a loss in target prices and deficiency payments (Scenario V) drops average net income to $10,600 after family living expenses are deducted, the farm retains a 98% probability for positive after-tax net present value and a 100% probability for survival. Overall, this representative farm retains a strong competitive economic position mainly because it grows by adding cropland. And, although

TABLE 9: Comparison of Selected Policy Scenarios on a Representative Medium Size (672-Acre) Irrigated Row Crop Farm in South Central Nebraska

Criteria	Initial Situation	Alternative Scenarios a/ I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	---	100	100	100	92	100	100	90	100
Probability of Positive After-Tax Net Present Value (%)	---	100	100	100	28	98	100	30	100
After-Tax net present value mean ($1,000)	---	424.8	501.1	424.8	-75.7	194.7	424.8	-78.0	425.9
Average present value of ending net worth ($1,000)	448.3	670.3	735.9	670.3	259.9	475.7	670.3	263.9	627.7
Average ending cropland owned (acres)	302.0	500.4	567.6	500.4	331.8	463.6	500.4	331.9	468.4
Average ending cropland leased (acres)	370.0	420.2	341.8	420.2	549.8	406.8	420.2	476.0	448.4
Average ending cropland controlled (acres)	672.0	920.6	909.4	920.6	881.6	870.4	920.6	808.0	916.8
Average ending long-term debts ($1,000)	123.2	283.3	365.6	283.3	205.3	314.7	283.3	213.7	260.8
Average ending intermediate-term debts ($1,000)	40.1	35.6	29.1	35.6	90.6	42.7	35.6	90.2	29.9
Average ending equity ratio (fraction)	0.72	0.71	0.68	0.70	0.52	0.62	0.71	0.52	0.71
Average internal rate of return (fraction)	---	0.10	0.11	0.10	-0.01	0.06	0.10	-0.01	0.10
Average annual net farm income ($1,000)	---	26.8	31.0	26.8	-9.8	10.6	26.8	-11.4	26.8
Average annual total government payments ($1,000)	---	17.3	14.5	17.3	1.0	1.0	17.3	0.0	17.9

a/ The scenarios are:
I — Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II — A 20% Acreage Reduction in 1986-1992.
III — No Farm Program Payment Limitation in 1983-1992.
IV — No Price Support and No Deficiency Payment in 1983-1992.
V — No Target Price/Deficiency Payment in 1983-1992.
VI — Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII — No Farm Program in 1983-1992.
VIII — Reduced Income Tax Benefits and the Base Farm Program.

annual operating expenses are higher than on Illinois farms because of irrigation expenses, the annual cost of servicing land purchases is much less than on the much higher priced Illinois land. As a result this representative farm adds to its owned cropland base of 302 acres by major land purchases (160 acres or more) in scenarios I, II, III, V, VI, and VIII, respectively. With the loss of basic price and income support programs (Scenarios IV and VII), on the other hand, land purchase occurs only in relatively small amounts (less than 30 acres).

2. The Large (920-acre) Farm:

This representative farm owns 228 acres more than the medium-size Nebraska farm at the outset. As a result its initial net worth is almost $400 thousand greater and its survival probability is 100% for all eight policy scenarios (Table 10). Its annual net farm income averages more than $57 thousand for those scenarios in which basic government price and income programs are retained (Scenarios I, II, III and VIII). These rather attractive income earnings are largely associated with the much lower costs of servicing land ownership than was true for the Illinois cash crop farms. As was true for the medium-size Nebraska farm, retention of all basic price and income supports provided under the 1981 farm legislation generates adequate income for farm growth via the purchase of additional land and, thus, to switch to reduced land rental and increased land ownership (Table 12).

As in the case of the medium-size farm, net present values drop dramatically, and ending net worths are reduced from their initial levels for the "large" farm when price and income supports are removed (Scenarios IV and VII). Also, net incomes drop to around zero for these two scenarios. But, the loss of deficiency payments (Scenario V) is not, by itself, completely disastrous to this large Nebraska farm. In fact, even without deficiency

TABLE 10: Comparison of Selected Policy Scenarios on a Representative Large Size (920-Acre) Irrigated Row Crop Farm in South Central Nebraska

Criteria	Initial Situation	Alternative Scenarios a/							
		I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	---	100	100	100	100	100	100	100	100
Probability of Positive After-Tax Net Present Value (%)	---	100	100	100	62	100	98	68	100
After-Tax net present value mean ($1,000)	---	816.2	849.9	833.5	14.6	475.2	590.4	22.6	807.5
Average present value of ending net worth ($1,000)	839.0	1349.1	1377.2	1369.1	739.4	1083.6	1180.1	749.6	1269.4
Average ending cropland owned (acres)	530.0	917.2	885.2	925.2	656.4	826.0	822.8	642.0	834.0
Average ending cropland leased (acres)	390.0	339.4	367.8	331.4	585.2	414.4	434.0	601.2	399.8
Average ending cropland controlled (acres)	920.0	1256.6	1253.0	1256.6	1241.6	1240.4	1256.8	1243.2	1233.8
Average ending long-term debts ($1,000)	102.0	401.2	321.6	419.2	200.0	328.1	341.3	192.3	305.5
Average ending intermediate-term debts ($1,000)	53.7	21.9	25.6	21.7	65.2	38.1	41.2	66.1	19.5
Average ending equity ratio (fraction)	0.84	0.76	0.27	0.76	0.77	0.77	0.77	0.78	0.78
Average internal rate of return (fraction)	---	0.10	0.10	0.10	0.02	0.07	0.08	0.02	0.10
Average annual net farm income ($1,000)	---	58.4	60.9	57.4	0.1	35.7	37.4	-0.5	58.9
Average annual total government payments ($1,000)	---	24.1	19.3	23.9	1.3	1.3	15.3	0.0	24.4

a/ The scenarios are:

I — Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II — A 20% Acreage Reduction in 1986-1992.
III — No Farm Program Payment Limitation in 1983-1992.
IV — No Price Support and No Deficiency Payment in 1983-1992.
V — No Target Price/Deficiency Payment in 1983-1992.
VI — Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII — No Farm Program in 1983-1992.
VIII — Reduced Income Tax Benefits and the Base Farm Program.

payments, the farm still maintains a 100% probability for a positive after-tax net present value (Table 10).

3. The Very Large (2085-acre) Farm:

This 2085-acre farm is already a very large operating unit with only modest incentive for additional growth. It already employs two full-time hired workers and has a large machinery investment. Thus, under the base scenario (and other scenarios retaining basic price and income supports) the farm grows in acreage in net amounts of 15% or less over the 10-year period 1983-1992. But, it changes its tenure structure materially by purchasing additional land and reducing the acreage rented. This is a logical adjustment for a farm firm which can do so without jeopardizing seriously its equity position or its survival probability. And, with a beginning equity ratio of 0.79 and a very strong initial net worth (almost $1.5 million) such an adjustment is very feasible. Even the recent severe drop in land prices would not have jeopardized the equity position of this large, high equity unit.

The large initial net worth for this representative farm results in a 100% probability of survival for all eight policy scenarios. Net worth grows by amounts in excess of $600 thousand from 1983-1992 for all scenarios where price and income supports are fully retained. And, net farm income reaches the level of $100 thousand plus. Internal rates of return are diminished slightly, however, from their rates for the medium and large farms. This probably results from the higher costs of full-time hired workers and greater machinery investment costs.

A loss of government price and income supports is rather devastating to this "very large" representative farm. Under scenarios IV and VII, the probability of positive after-tax net present value drops to 12% or less and the average value for this measure turns negative in amounts of about $300

TABLE 11: Comparison of Selected Policy Scenarios on a Representative Very Large Size (2085-Acre) Irrigated Row Crop Farm in South Central Nebraska

Criteria	Initial Situation	Alternative Scenarios a/ I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	---	100	100	100	100	100	100	100	100
Probability of Positive After-Tax Net Present Value (%)	---	100	100	100	8	100	42	12	100
After-Tax net present value mean ($1,000)	---	1379.4	1520.2	1587.8	-290.4	870.7	-5.8	-301.9	1388.5
Average present value of ending net worth ($1,000)	1463.1	2258.8	2373.8	2406.8	1012.8	1862.6	1270.1	1006.5	2072.3
Average ending cropland owned (acres)	1042.0	1627.6	1640.4	1664.4	1134.8	1515.6	1256.4	1133.2	1397.2
Average ending cropland leased (acres)	1043.0	747.0	742.2	719.8	1031.8	764.6	940.6	995.0	932.6
Average ending cropland controlled (acres)	2085.0	2374.6	2382.6	2384.2	2166.6	2280.2	2197.0	2128.2	2329.8
Average ending long-term debts ($1,000)	291.1	606.2	584.8	617.5	316.3	527.6	399.7	319.2	422.9
Average ending intermediate-term debts ($1,000)	98.0	77.5	66.4	40.0	246.7	93.5	247.3	244.7	29.9
Average ending equity ratio (fraction)	0.79	0.77	0.78	0.78	0.70	0.76	0.71	0.69	0.80
Average internal rate of return (fraction)	---	0.09	0.10	0.10	-0.01	0.07	0.02	-0.01	0.10
Average annual net farm income ($1,000)	---	118.6	127.3	134.6	1.3	88.0	10.8	-0.1	112.8
Average annual total government payments ($1,000)	---	35.9	31.5	49.6	3.0	3.0	0.0	0.0	35.9

a/ The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

TABLE 12: Rates of Change in Selected Farm Size, Wealth and Financial Characteristics for Alternative Policy Scenarios for Representative Irrigated Row Crop Farms in South Central Nebraska

Criteria	Initial Situation	Percentage Change in Variable Level From Initial Situation For Alternative Scenarios a/							
		I	II	III	IV	V	VI	VII	VIII
		672-Acre Farm							
Present value of ending net worth ($1,000)	448.3	+50	+64	+50	-42	+6	+50	-41	+40
Cropland owned after 10 years (acres)	302.0	+66	+88	+66	+10	+54	+66	+10	+55
Cropland leased after 10 years (acres)	370.0	+14	-8	+14	+49	+10	+14	+29	+21
Total cropland controlled after 10 years (acres)	672.0	+37	+35	+37	+31	+30	+37	+20	+36
Total long-term debts after 10 years ($1,000)	123.2	+130	+197	+130	+67	+155	+130	+73	+112
Total intermediate-term debts after 10 years ($1,000)	40.1	-11	-27	-11	+126	+6	-11	+125	-25
Total equity to asset ratio after 10 years (%) b/	72.0	71	68	70	52	62	71	52	71

Criteria	Initial Situation	I	II	III	IV	V	VI	VII	VIII
		920-Acre Farm							
Present value of ending net worth ($1,000)	839.0	+61	+64	+63	-12	+29	+41	-11	+51
Cropland owned after 10 years (acres)	530.0	+73	+67	+75	+56	+55	+55	+21	+57
Cropland leased after 10 years (acres)	390.0	-13	-6	-15	+50	+6	+11	+54	+3
Total cropland controlled after 10 years (acres)	920.0	+37	+36	+37	+35	+35	+37	+35	+34
Total long-term debts after 10 years ($1,000)	102.0	+293	+215	+311	+96	+222	+235	+89	+200
Total intermediate-term debts after 10 years ($1,000)	53.7	-59	-52	-59	+21	-29	-23	+23	-64
Total equity to asset ratio after 10 years (%) b/	84.0	76	27	76	77	77	77	78	78

Criteria	Initial Situation	I	II	III	IV	V	VI	VII	VIII
		2085-Acre Farm							
Present value of ending net worth ($1,000)	1463.1	+54	+62	+65	-31	+27	-13	-31	+42
Cropland owned after 10 years (acres)	1042.0	+56	+57	+60	+9	+45	+21	+9	+34
Cropland leased after 10 years (acres)	1043.0	-28	-29	-31	-1	-27	-10	-5	-11
Total cropland controlled after 10 years (acres)	2085.0	+14	+14	+14	+4	+9	+5	+2	+12
Total long-term debts after 10 years ($1,000)	291.1	+108	+101	+112	+9	+81	+37	+10	+45
Total intermediate-term debts after 10 years ($1,000)	98.0	-21	-32	-59	+152	-5	+152	+150	-70
Total equity to asset ratio after 10 years (%) b/	79.0	77	78	78	70	76	71	69	80

a/ The scenarios are:

I -- Base Change or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Deficiency Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

b/ Values for all policy scenarios represent the percent equity in total assets after 10 years, not the percentage changes in these equity to asset ratios.

thousand. As might be expected, net worth also drops by very large amounts. Targeting program benefits to farms with $300 thousand or less (Scenario VI) hits this farm proportionately the hardest of all of the six Illinois-Nebraska farms considered, since even under the base scenario it produces program crops in an average amount of over $700 thousand annually.

4. A Comparison Between Farms:

The medium-size (672-acre) Nebraska farm prospers economically with a continuation of basic price and income support programs. But, its modest beginning net worth makes it's equity position vulnerable to the loss of these program benefits particularly with declines in land prices of the magnitude experienced since 1981. The incentives are great for this farm to grow by purchasing additional cropland in amounts of 160 acres or more when price and income programs are retained. But, growth is achieved mainly by leasing land in the absence of these program benefits.

The large (920-acre) farm is better financed and, as a result, its probability of survival is 100% under all policy scenarios. It, too, has good income earnings and incentives for major growth via cropland purchase when basic price and income support programs are retained.

The very large (2085-acre) farm has exploited most of its growth potential under current price and income programs. But, these program benefits provide incentives to shift from land leasing to land ownership. Clearly, such a shift is better undertaken with lower, rather than higher, land prices.

As a general rule, the reduction in income tax benefits considered in Scenario VIII does not have major effects on any of the three representative farms. It does, however, have the greatest impact on the "very large" farm. For example, average annual net farm income for this unit is lowered by $5,800 by the reduction in income tax benefits as compared to the base scenario.

All three representative farms realize a major deterioration in their economic status with the loss of price and income supports. They are, however, in a better position to absorb the loss of target price/deficiency payment programs than is the case for the representative farms in East Central Illinois. This appears to be mainly the result of their much lower "land cost structure" compared to the Illinois farms.

Results For Financial Bailout Scenarios

Two farm credit policy alternatives were evaluated as to their potential for helping highly leveraged farmers remain solvent. The first was a debt restructuring policy whereby intermediate-term debt was refinanced and the repayment period was lengthened from six years to seven. Also, within the limits of the equity constraints specified, farm operators could shift a portion of intermediate-term debt to long-term. The second financial bailout alternative was that of providing highly leveraged farmers with an interest rate reduction (subsidy) in the first two years to help offset the adverse impacts of high real interest rates. Interest rate subsidies of 3.4 percentage points on real estate debt and 5.4 percentage points for intermediate-term credit were applied in order to bring real interest rates down to 4 percent per year.

To simulate the effects of these two financial bailout alternatives, the financial positions of the six representative farms were modified to depict much higher leveraging than the original situations (those depicted in Tables 1A and 1B). Specifically, intermediate-term debts (machinery loans) were set at 60% of machinery costs and long-term debts (real estate loans) were set at 55% of land costs for all farms. This resulted in an overall equity-to-asset ratio of 46% on Illinois farms and of 44 to 45% on Nebraska farms. In addition, annual interest rates were increased to their average values for 1980-1983 (11.4% for long-term and 13.4% for intermediate-term). The resulting "initial financial situations" are shown in Column 1 of Table 14 for Illinois farms and in Column 1 of Table 16 for Nebraska farms.

Scenario IX (Tables 13 and 15) illustrates the impact on the representative farms of these highly leveraged debt situations with a continuation of current government programs of price and income supports, but without any program for financial bailout. Scenario X (also shown in Tables 13 and 15) depicts the simulations with the debt restructuring bailout alternative and Scenario XI depicts the effects of the interest rate reduction (subsidy) alternative.

A. The Illinois Farms

The much higher leverage ratios assumed for the new base scenario (Scenario IX) drop the probabilities for survival to below 100% for all but the very large Illinois farm (Table 13). And, the probabilities of positive after-tax net present values drop to 16, 60 and 90%, respectively for the medium, large and very large farms. Moreover, by 1992, at the end of the ten year simulation, the present value of net worth has dropped by 41 and 21%, respectively, for the medium and large farming operations and their internal rates of return are -0.01 and 0.02, respectively. These statistics, coupled with continued high ending period debts and low net farm incomes, present a poor economic outlook for the medium and large Illinois farms.

As a result of a higher proportion of land renting and a resulting reduced relative land debt load drag, the very large farm generates much better measures of economic performance. But even for this very large farm, net income averages only about $37,000 per year.

TABLE 13: Comparison of Selected Financial Bailout Scenarios for Three Representative Corn-Soybean Farms in East Central Illinois

Criteria	Alternative Scenarios for 640-Acre Farm a/			Alternative Scenarios for 982-Acre Farm a/			Alternative Scenarios for 1630-Acre Farm a/		
	IX	X	XI	IX	X	XI	IX	X	XI
Probability of Survival (%)	80	72	84	88	80	90	100	100	100
Probability of Positive After-Tax Net Present Value (%)	16	26	36	60	64	68	90	94	92
After-Tax net present value mean ($1,000)	-97.8	-79.3	-62.4	-27.5	-24.2	56.7	275.5	327.5	303.4
Average present value of ending net worth ($1,000)	270.7	290.9	298.7	579.3	587.9	653.6	822.0	872.1	831.4
Average ending cropland owned (acres)	231.6	251.2	238.7	395.7	415.4	425.8	467.6	467.6	469.2
Average ending cropland leased (acres)	421.2	417.6	423.7	650.3	646.6	647.4	1327.0	1272.8	1242.4
Average ending cropland controlled (acres)	652.8	688.8	662.4	1046.0	1062.0	1073.2	1794.8	1740.4	1711.6
Average ending long-term debts ($1,000)	446.1	511.9	440.2	738.1	828.2	788.9	794.4	865.3	775.8
Average ending intermediate-term debts ($1,000)	35.9	46.4	39.4	76.0	56.5	59.1	59.0	11.5	46.0
Average ending equity ratio (fraction)	0.40	0.38	0.43	0.44	0.43	0.47	0.55	0.56	0.57
Average internal rate of return (fraction)	-0.01	0.01	0.01	0.02	0.03	0.05	0.08	0.08	0.07
Average annual net farm income ($1,000)	-0.9	-3.3	3.8	2.0	-3.5	7.8	30.6	27.9	36.9
Average annual total government payments ($1,000)	8.9	8.9	9.1	19.2	18.9	19.0	23.0	22.8	22.8

a/ The scenarios are:
IX - Continuation of the 1981 Farm Bill and 1983 federal tax provisions for a highly leveraged farm.
X - Restructure debt for a highly leveraged farm.
XI - Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

TABLE 14: Rates of Change in Selected Farm Size, Wealth and Financial Characteristics for Alternative Financial Bailout Scenarios for Three Representative Corn-Soybean Farms in East Central Illinois

Criteria	Initial Situation	Percentage Change in Variable Level From Initial Situation for Alternative Scenarios a/		
		IX	X 640-Acre Farm	XI
Present value of ending net worth ($1,000)	461.0	-41	-37	-35
Cropland owned after 10 years (acres)	260.0	-11	-3	-8
Cropland leased after 10 years (acres)	380.0	+11	+10	+12
Total cropland controlled after 10 years (acres)	640.0	+2	+8	+4
Total long-term debts after 10 years ($1,000)	495.3	-10	+3	-11
Total intermediate-term debts after 10 years ($1,000)	55.3	-35	-16	-29
Total equity to asset ratio after 10 years (%) b/	46.0	40	38	43

Criteria	Initial Situation	IX	X 982-Acre Farm	XI
Present value of ending net worth ($1,000)	737.1	-21	-20	-11
Cropland owned after 10 years (acres)	429.0	-8	-3	-1
Cropland leased after 10 years (acres)	553.0	+18	+17	+17
Total cropland controlled after 10 years (acres)	982.0	+7	+8	+9
Total long-term debts after 10 years ($1,000)	814.4	-9	+2	-3
Total intermediate-term debts after 10 years ($1,000)	62.9	+21	-10	-6
Total equity to asset ratio after 10 years (%) b/	46.0	44	43	47

Criteria	Initial Situation	IX	X 1630-Acre Farm	XI
Present value of ending net worth ($1,000)	781.8	+5	+12	+6
Cropland owned after 10 years (acres)	458.0	+2	+2	+2
Cropland leased after 10 years (acres)	1172.0	+13	+9	+6
Total cropland controlled after 10 years (acres)	1630.0	+10	+7	+5
Total long-term debts after 10 years ($1,000)	846.1	-6	+2	-8
Total intermediate-term debts after 10 years ($1,000)	77.4	-24	-85	-41
Total equity to asset ratio after 10 years (%) b/	46.0	55	56	57

a/ The scenarios are:
IX - Continuation of the 1981 Farm Bill and 1983 federal tax provisions for a highly leveraged farm.
X - Restructure debt for a highly leveraged farm.
XI - Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

b/ Values for all scenarios represent the percent equity in total assets after 10 years not the percentage change in these equity to asset ratios.

Scenario X (financial bailout via debt restructuring) alleviates economic stress and improves most economic measures modestly for all three Illinois farms. However, the real estate debt load is so burdensome, and the cost of its servicing so high relative to the income generated, that debt restructuring provides only modest financial relief. And, it fails to improve at all the survival probability for the medium and large farms.

Scenario XI (financial bailout via an interest rate subsidy) does improve the survival probability and the probability of positive after-tax net present value for the medium and large farms compared to the base heavy debt scenario (Scenario IX). But ending period net worth for these two farms is reduced substantially (dramatically for the medium-size farm) from its initial (1982) level (Table 14). This coupled with extremely low net farm income levels results in the continuation of a rather dismal economic outlook. But, an interest rate subsidy does provide some modest economic relief.

Under all three of the increased financial leverage scenarios (Scenarios IX, X and XI) the 640-acre and 982-acre farms continue to experience pressures for growth in size. But the high debt load and high cash flow requirements preclude additional land purchase and limit any expansion to that achieved by leasing.

B. The Nebraska Farms

As indicated in Tables 15 and 16, the three representative farms in South Central Nebraska remain economically viable even under conditions of high financial leverage (Scenario IX). As before, the medium (672-acre) and large (920-acre) farms continue to show significant growth potential via both the purchase and lease of additional cropland. Growth potential is less for the very large (2085-acre) farm although limited cropland purchase is still a profitable option. All farms remain heavily indebted at the end of the

TABLE 15: Comparison of Selected Financial Bailout Scenarios for Three Representative Irrigated Row-Crop Farms in South Central Nebraska

Criteria	Alternative Scenarios for 672-Acre Farm a/			Alternative Scenarios for 920-Acre Farm a/			Alternative Scenarios for 2085-Acre Farm a/		
	IX	X	XI	IX	X	XI	IX	X	XI
Probability of Survival (%)	96	86	98	100	100	100	100	100	100
Probability of Positive After-Tax Net Present Value (%)	100	100	100	100	100	100	100	100	100
After-Tax net present value mean ($1,000)	242.8	219.4	292.3	625.8	623.6	671.4	1224.5	1415.5	1307.3
Average present value of ending net worth ($1,000)	352.9	333.9	387.1	870.6	876.4	892.9	1684.9	1820.1	1714.0
Average ending cropland owned (acres)	388.4	404.4	401.2	701.2	731.6	720.4	1416.4	1555.6	1438.8
Average ending cropland leased (acres)	434.0	418.0	453.2	494.2	414.2	484.4	982.2	836.6	982.2
Average ending cropland controlled (acres)	822.4	822.4	854.4	1195.4	1145.8	1204.8	2398.6	2392.2	2421.0
Average ending long-term debts ($1,000)	417.5	467.6	412.2	658.4	739.9	662.9	1247.1	1386.0	1218.5
Average ending intermediate-term debts ($1,000)	64.1	69.2	54.4	49.1	50.6	47.2	136.6	94.2	106.9
Average ending equity ratio (fraction)	0.48	0.44	0.51	0.59	0.57	0.60	0.59	0.58	0.60
Average internal rate of return (fraction)	0.09	0.09	0.10	0.13	0.13	0.13	0.12	0.13	0.13
Average annual net farm income ($1,000) b/	5.9	2.9	11.3	22.6	16.7	28.2	58.9	77.2	72.1
Average annual total government payments c/ ($1,000)	16.7	16.8	17.0	23.0	22.6	22.9	36.0	36.0	36.1

a/ The scenarios are:
IX - Continuation of the 1981 Farm Bill and 1983 federal tax provisions for a highly leveraged farm.
X - Restructure debt for a highly leveraged farm.
XI - Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

TABLE 16: Rates of Change in Selected Farm Size, Wealth and Financial Characteristics for Alternative Financial Bailout Scenarios for Three Representative Irrigated Row-Crop Farms in South Central Nebraska

Criteria	Initial Situation	Percentage Change in Variable Level From Initial Situation for Alternative Scenarios a/		
		672-Acre Farm		
		IX	X	XI
Present value of ending net worth ($1,000)	263.0	+34	+27	+47
Cropland owned after 10 years (acres)	302.0	+29	+34	+33
Cropland leased after 10 years (acres)	370.0	+17	+13	+22
Total cropland controlled after 10 years (acres)	672.0	+22	+22	+27
Total long-term debts after 10 years ($1,000)	262.7	+59	+78	+57
Total intermediate-term debts after 10 years ($1,000)	61.7	+4	+12	-12
Total equity to asset ratio after 10 years (%) b/	44.0	48	44	51

Criteria	Initial Situation	920-Acre Farm		
		IX	X	XI
Present value of ending net worth ($1,000)	432.7	+101	+103	+106
Cropland owned after 10 years (acres)	530.0	+32	+38	+36
Cropland leased after 10 years (acres)	390.0	+27	+6	+24
Total cropland controlled after 10 years (acres)	920.0	+30	+25	+31
Total long-term debts after 10 years ($1,000)	461.1	+43	+60	+44
Total intermediate-term debts after 10 years ($1,000)	67.3	-27	-25	-30
Total equity to asset ratio after 10 years (%) b/	44.6	59	57	60

Criteria	Initial Situation	2085-Acre Farm		
		IX	X	XI
Present value of ending net worth ($1,000)	835.0	+102	+118	+105
Cropland owned after 10 years (acres)	1042.0	+36	+49	+38
Cropland leased after 10 years (acres)	1043.0	-6	-20	-6
Total cropland controlled after 10 years (acres)	2085.0	+15	+15	+16
Total long-term debts after 10 years ($1,000)	906.6	+38	+53	+34
Total intermediate-term debts after 10 years ($1,000)	110.4	+24	-15	-3
Total equity to asset ratio after 10 years (%) b/	44.9	59	58	60

a/ The scenarios are:
IX - Continuation of the 1981 Farm Bill and 1983 federal tax provisions for a highly leveraged farm.
X - Restructure debt for a highly leveraged farm.
XI - Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

b/ Values for all scenarios represent the percent equity in total assets after 10 years not the percentage change in these equity to asset ratios.

simulation period (1992). As compared to the initial base scenario (Scenario I, which had much lower financial leverage), Scenario IX generates much lower levels of net farm income. These low levels of income provide little economic reward for the risk associated with bearing a heavy debt load. And, they provide very little safety margin to protect against a number of possible economic adversities. In short, the costs of servicing this expanded debt load reduce dramatically the profitability and increase the risk of all three farming operations.

The financial bailout alternative which permits debt restructuring (Scenario X), benefits the very large farm substantially while helping the smaller (672- and 920-acre farms) not at all. The latter two representative farms have continuing growth pressures. As a result, they gain very little from shifting their debt to a longer-term (real estate) basis. Meanwhile, the very large farm is able to ease its cash flow pressures in the short-term through debt restructuring. In the process, its average net income is boosted by 31 percent to $77,200.

The second financial bailout alternative (Scenario XI) provides a two-year interest rate subsidy which reduces the debt servicing burden (per dollar borrowed) for all three representative farms. And, since it also has the net effect of reducing total costs, it boosts the net farm income levels for all farms compared to Scenario IX. As might be expected, the greatest economic benefits accrues to the largest farm since it has the largest debt. None-the-less, the 672- and 920-acre farms do benefit more from the interest rate subsidy than they do from a financial bailout via debt restructuring. The very large farm, on the other hand, benefits less than from the debt restructuring option. For all three farms an interest rate subsidy not only improves net farm income but it also reduces financial risk by increasing the safety margin for dealing with unexpected economic adversities.

No New Technology 1983-1992

Policy Scenarios I through VIII were simulated under an assumption of the most likely production technology expected to occur over the decade 1983-1992. And, any new technology was assumed to be adopted most rapidly by very large farms and least rapidly by the medium-size units.

Scenarios XII, XIII and XIV (Table 17) are simulations of three of the initial policy scenarios (Scenarios I, V and VII), but with the assumption that there would be no new technology during the 1983-1992 period. A comparison of the simulations with "most likely technology" and with "no new technology" scenarios provides some perspective on the significant role which the availability of new technology serves for early adopters. The simulation analysis reported here does have the limitation of being a "partial analysis." Thus it does not incorporate the price reducing feedback which might be expected when new output increasing technology is adopted by a substantial number of producers.

1. The Illinois Farms:

A comparison of Table 17 (simulation results with no new technology) and Scenarios I, V and VII in Tables 5, 6 and 7 (simulation results with "most likely" technology) suggests the following:

a) Economic performance measures for the medium-size (640-acre) farm are affected little, if any, by the elimination of new technology.

b) Economic performance measures for the large (982-acre) farm deteriorate modestly in the absence of new technology with the most significant reductions occurring in net present value and ending net worth.

TABLE 17: Comparison of Selected Farm Policy Alternatives Assuming No New Technology for Three Representative Corn-Soybean Farms in East Central Illinois

Criteria	Alternative Scenarios for 640-Acre Farm a/			Alternative Scenarios for 982-Acre Farm a/			Alternative Scenarios for 1630-Acre Farm a/		
	XII	XIII	XIV	XII	XIII	XIV	XII	XIII	XIV
Probability of Survival (%)	100	100	100	100	100	100	100	100	98
Probability of Positive After-Tax Net Present Value (%)	36	6	4	54	0	0	68	6	12
After-Tax net present value mean ($1,000)	-9.1	-145.5	-175.9	17.1	-294.4	-367.5	41.9	-222.2	-252.4
Average present value of ending net worth ($1,000)	699.2	589.3	561.2	862.1	603.6	539.5	914.5	693.9	672.1
Average ending cropland owned (acres)	375.2	309.6	295.2	525.0	437.5	428.0	630.8	518.8	489.7
Average ending cropland leased (acres)	527.2	527.2	554.4	866.6	752.5	688.4	1268.0	1282.4	1306.7
Average ending cropland controlled (acres)	902.4	836.8	849.6	1391.6	1190.0	1116.4	1898.8	1801.2	1796.4
Average ending long-term debts ($1,000)	260.4	169.1	154.0	665.4	519.4	504.5	757.9	607.9	547.6
Average ending intermediate-term debts ($1,000)	10.6	26.6	33.1	40.1	116.2	140.6	120.4	166.4	175.6
Average ending equity ratio (fraction)	0.76	0.79	0.79	0.61	0.56	0.53	0.57	0.54	0.54
Average internal rate of return (fraction)	0.03	0.01	0.01	0.04	0.00	-0.01	0.04	0.01	0.00
Average annual net farm income ($1,000)	23.0	11.7	10.8	23.9	3.3	-0.8	25.3	9.8	6.1
Average annual total government payments ($1,000)	11.6	0.7	0.0	22.9	1.0	0.0	22.9	1.7	0.0

a/ The scenarios are:
XII - Continuation of the 1981 Farm Bill and 1983 federal tax provisions, assuming no new technology scenario.
XIII - No Target Price/Deficiency Payment program, assuming no new technology scenario.
XIV - No Farm Program in 1983-1992, assuming no new technology scenario.

c) A major deterioration in economic performance measures occurs for the very large farm when new technology is eliminated. This deterioration occurs both with and without the benefits of government programs. For example, for the base scenario (Scenario XII compared to Scenario I) elimination of new technology results in the following reductions: Net income - 51%, after-tax net present value - 88% and present value of ending net worth - 28%. Similar reductions occur even with no farm programs (Scenario XIV as compared to Scenario VII). Thus, within the framework of our analysis, at least, the earning capability of the very large farm relates closely to it's ability to adopt new production technology.

2. The Nebraska Farms:

The impact of eliminating new technology follows a very similar pattern for the Nebraska farms as for the Illinois farms. There is no effect on economic measures for the medium-size (672-acre) farm, only a very modest impact on the large (920-acre) farm and a dramatic impact on the very large (2085-acre) farm (Table 18 compared with Scenarios I, V and VII in Tables 9-11). In fact, with no new technology and no farm programs for 1983-1992, the probability of a positive net present value for the very large farm drops to zero and net farm income drops to a -$10,900 (Scenario XIV).

There are, of course, early adopters of new technology among the medium- and large-size farms and they too would suffer economically from the loss of new technology. But the heaviest concentration of early technology adopters is projected to be in the very large farm group.

TABLE 18: Comparison of Selected Farm Policy Alternatives Assuming No New Technology for Three Representative Irrigated Row-Crop Farms in South Central Nebraska

Criteria	Alternative Scenarios for 672-Acre Farm a/			Alternative Scenarios for 920-Acre Farm a/			Alternative Scenarios for 2085-Acre Farm a/		
	XII	XIII	XIV	XII	XIII	XIV	XII	XIII	XIV
Probability of Survival (%)	100	100	90	100	100	100	100	100	100
Probability of Positive After-Tax Net Present Value (%)	100	98	30	100	98	42	100	70	0
After-Tax net present value mean ($1,000)	424.1	193.9	-78.7	688.9	370.1	-57.8	802.7	291.8	-642.7
Average present value of ending net worth ($1,000)	669.7	474.9	263.2	1230.1	985.2	670.6	1811.9	1387.5	680.1
Average ending cropland owned (acres)	500.4	463.6	331.9	901.2	819.6	638.8	1565.2	1422.8	1055.4
Average ending cropland leased (acres)	420.2	406.8	476.0	355.4	401.8	586.8	836.6	817.4	1051.9
Average ending cropland controlled (acres)	920.6	870.4	808.0	1256.6	1221.4	1225.6	2401.8	2240.2	2107.4
Average ending long-term debts ($1,000)	284.1	315.0	213.8	392.2	349.3	205.9	693.7	573.5	327.5
Average ending intermediate-term debts ($1,000)	35.8	42.8	90.4	31.4	44.0	68.5	108.9	129.9	250.9
Average ending equity ratio (fraction)	0.70	0.62	0.51	0.75	0.74	0.75	0.71	0.69	0.60
Average internal rate of return (fraction)	0.10	0.06	-0.01	0.09	0.06	0.01	0.07	0.04	-0.05
Average annual net farm income ($1,000)	26.7	10.6	-11.4	53.9	30.3	-2.6	77.5	51.0	-10.9
Average annual total government payments ($1,000)	17.3	0.9	0.0	23.9	1.3	0.0	35.7	3.0	0.0

a/ The scenarios are:
XII - Continuation of the 1981 Farm Bill and 1983 federal tax provisions, assuming no new technology scenario.
XIII - No Target Price/Deficiency Payment program, assuming no new technology scenario.
XIV - No Farm Program in 1983-1992, assuming no new technology scenario.

Analysis For New Entrants

The simulation analysis for Scenarios I through XIV assumed that the six representative farms were operated by farmers who were already well established in their operations. These types of analyses provide economic insights of mainly a short-term nature. They do not provide information on economic well being and survivability of farmers who are just getting established in farming (new entrants).

The medium size (640-acre Illinois and 672-acre Nebraska) representative farms were adjusted to correspond to situations which might be faced by new entrants. The entering farm operator was assumed to have minimum equity in purchased cropland (30%) and machinery (35%). All machinery was priced at its new (1982) cost. Annual interest rates for current real estate and intermediate-term loans were set equal to average interest rates for 1980-83 (11.37% and 13.4%, respectively). Three scenarios were evaluated for each of these two new entrants. Scenario XV represents a continuation of current farm programs and tax regulations (comparable to the base scenario, Scenario I). Scenario XVI is comparable to Scenario V (no target price/deficiency payment programs). Scenario XVII is comparable to Scenario VII (no farm program in 1983-1992).

The Illinois 640-acre Farm

As for the earlier analysis, the Illinois farmer was assumed to operate 260 acres of purchased cropland and 380 acres of rented cropland, all tillable. In order to meet even the minimal equity requirements listed above (30% for real estate and 35% for machinery) an initial net worth of over $400 thousand is required. And the initial debt load is almost $800 thousand.

An alternative scenario, not considered here, would be that of allowing the new entrant to start farming with only rented land. As a practical matter, however, it is often difficult for a new entrant to compete in the land rental market without having ownership control of at least some cropland.

Table 19 reports the initial situation for the Illinois new entrant and the simulated outcomes under Scenarios XV, XVI and XVII. Faced with high land prices, expensive machinery, low initial equity, and high interest rates, the economic viability of this farm operation is essentially zero. Even the continuation of existing price and income supports do not cover the high cash flow requirements for this low equity operation. The only question is how long the farm operator can stay in business. As a practical matter, a new, low-equity farming entrant in the cash-crop area of Illinois can probably only survive by the successful implementation of one or more of the following management strategies:

1) Use of mainly leased land and/or machinery,
2) Achievement of much higher than average crop yields,
3) A financial arrangement that postpones a part of the initial period liability for principal and/or interest repayment.

The net farm incomes and after-tax net present values shown in Table 19 for all three scenarios, are negative in large amounts. Thus even the successful implementation of the strategies listed above is not likely to ensure the successful establishment of this new entrant in farming.

The 672-acre Nebraska Farm

This Nebraska farmer was assumed to operate 302 acres of purchased cropland and 370 acres of rented cropland, again all tillable. Minimal equity requirements require an initial net worth of $268 thousand and a total debt load of about $530 thousand. Although this debt load is still very high, it is much lower than for the Illinois farm primarily because of a much lower land cost. Yet, with the use of irrigation technology, the corn and soybean

TABLE 19: Comparison of Selected Farm Policy Alternatives for a New Entrant on a Representative 640-Acre Corn-Soybean Farm in East Central Illinois

Criteria	Initial Situation	Alternative Scenarios[a] XV	XVI	XVII
Probability of Survival (%)	---	2	0	4
Probability of Positive Net Present Value (%)	---	0	0	0
After-tax net present value mean ($1,000)	---	-189.6	-209.2	-211.8
Average present value of ending net worth ($1,000)	423.4	220.9	202.0	196.6
Average ending cropland owned (acres)	260.0	210.1	203.4	192.3
Average ending cropland leased (acres)	380.0	430.0	436.6	447.7
Average ending cropland controlled (acres)	640.0	640.0	640.0	640.0
Average ending long-term debts ($1,000)	585.4	470.5	454.8	427.7
Average ending intermediate-term debts ($1,000)	208.5	206.5	214.0	207.2
Average ending equity ratio (fraction)	0.35	0.23	0.23	0.25
Average internal rate of return (fraction)	---	-0.01	-0.01	0.01
Average annual net farm income ($1,000)	---	-56.9	-61.1	-62.8
Average annual gov't payments ($1,000)	---	9.6	6.1	0.0

a/ The scenarios are:

XV - Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions
XVI - No Target Price/Deficiency Payment in 1983-1992
XVII - No Farm Program in 1983-1992

yields achieved are very comparable to those in East Central Illinois.

As indicated in Table 20, despite a much lower cost structure for land, the probability of survival for this "new entrant" Nebraska farming unit is only 56% under scenario XV (continuation of existing price and income support programs) and this probability declines to 26% with the removal of programs for target prices and deficiency payments. Survival probability drops to only 4% in Scenario XVII where no farm programs are operational for 1983-1992.

Average annual net farm income is negative for all three "new entrant" scenarios indicating that none of the scenarios are really economically feasible. Thus, to become successfully established in farming, this new entrant would also probably have to follow one or more of the management strategies suggested for the new entrant in Illinois. But, the chances for successful establishment in farming are somewhat better than for the new entrant in Illinois.

A General Summary of Simulation Results

Several alternatives were simulated for the ten year period 1983 to 1992 with respect to:

a) farm program options or lack thereof,

b) income tax provisions,

c) debt load levels and financial bailouts,

d) available technologies (mainly reflected in crop yields), and

e) the status of new entrants into farming.

The results of these complex simulations are not easily summarized, but some highlight findings are reported below.

A. Farm Program Alternatives

1. The Illinois Farms:

All three Illinois farms have a survival probability at or near 100%

TABLE 20: Comparison of Selected Farm Policy Alternatives for a New Entrant on a Representative 672-Acre Row-Crop Farm in South Central Nebraska

Criteria	Initial Situation	Alternative Scenarios[a/] XV	XVI	XVII
Probability of Survival (%)	---	84	42	6
Probability of Positive Net Present Value (%)	---	64	24	0
After-tax net present value mean ($1,000)	---	22.7	-71.5	-235.8
Average present value of ending net worth ($1,000)	268.0	187.4	106.1	355.6
Average ending cropland owned (acres)	302.0	199.6	121.4	157.2
Average ending cropland leased (acres)	370.0	474.0	544.2	514.7
Average ending cropland controlled (acres)	672.0	673.6	665.6	671.9
Average ending long-term debts ($1,000)	310.5	213.0	117.1	152.3
Average ending intermediate-term debts ($1,000)	219.2	107.4	154.6	203.3
Average ending equity ratio (fraction)	0.33	0.45	0.33	0.00
Average internal rate of return (fraction)	---	0.12	0.09	-0.32
Average annual net farm income ($1,000)	---	-19.2	-35.8	-56.6
Average annual gov't payments ($1,000)	---	14.5	1.2	0.0

a/ The scenarios are:

XV - Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions
XVI - No Target Price/Deficiency Payment in 1983-1992
XVII - No Farm Program in 1983-1992

under the entire range of farm program (and no program) alternatives considered here. But, the probability of positive after-tax net present value drops dramatically [particularly for the medium (640-acre) and large (982-acre) farms] when farm program benefits are reduced or removed. In fact, even the loss of target price/deficiency payment programs drops the probability of positive after-tax net present value into the range of 4 to 6% for these two representative farms. As a general rule, the largest farm fares the best with the loss of farm programs because it operates with a substantial acreage of rented land and suffers relatively less from the economic drag of servicing a high real estate debt load. Moreover, this very large unit has much less economic incentive to grow in size than do the two smaller farms.

2. The Nebraska Farms:

All three Nebraska farms also have a survival probability at or near 100% under the entire range of program and no program alternatives. The loss of farm program benefits has its greatest adverse impact on the very large (2085-acre) farm probably because this unit has large machinery investments and utilizes much more full-time hired labor. In fact, the probability of realizing positive after-tax net present value drops to the 8 to 12% range for this very large operation when program benefits are withdrawn or dramatically reduced. Economic performance measures for the medium (672-acre) and large (920-acre) farm also deteriorate under the latter conditions. Overall, the generally stronger economic viability of the Nebraska farms (compared to Illinois farms) is attributable to much lower land prices and the lower debt servicing costs which result.

B. Income Tax Provisions

A modest reduction in income tax benefits does not have major economic impacts on the medium and large farms in either Illinois or Nebraska. It has its greatest impact (a reduction of $5800 in net farm income compared to the base scenario) for the very large (2085-acre) farm in Nebraska. Even here, however, the impact is very small compared to the loss of economic benefits from either the target price/deficiency payment program or the entire complement of existing price and income supports.

C. Increased Debt Load and Financial Bailouts

Increasing debt loads to a level of 60% of machinery value and 55% of land value resulted in a heavy economic drag on all three Illinois farms but somewhat less so for the Nebraska farms. This difference results mainly from the much higher land prices on Illinois farms. Whereas survival probabilities drop to as low as 72% for the 640-acre Illinois farm, they drop only to 86% for the 672-acre Nebraska unit. Similarly, the probabilities for positive after-tax net present values drop to as low as 16% for the 640-acre Illinois farm but remain at 100% for all three Nebraska farms.

Because of the heavy real estate debt load on Illinois farms, they continue to have severe economic problems with either a debt restructuring or an interest rate subsidy type of financial bailout. Of the two, however, the interest rate subsidy is the most beneficial alternative,particularly for the smaller (640- and 982-acre) farms. Similarly, the interest rate subsidy is a preferable type of financial bailout (as compared to debt restructuring) for the two smallest Nebraska farms. Faced with substantial incentives for additional growth in size they are not in a position to profit appreciably from debt restructuring. A financial bailout in the form of an interest rate subsidy does improve net farm incomes and provides a "margin of safety" in the event of unexpected economic adversities.

D. No New Technology

The impact of eliminating new technology falls mainly on the very large farms. They tend to be the early adopters of new technology which generally has a very favorable benefit/cost ratio. One should keep in mind, however, that the simulation analysis conducted here did not permit feedback on the price effects from increased output levels.

E. New Entrants

Because of high land and machinery costs the survival probability for new entrants in Illinois is very low (0 to 4%). It is much higher (84%) for the base scenario on the 672-acre Nebraska farm. But this probability drops to only 6% with the loss of all farm programs. Thus the economic survival of new entrants is particularly dependent on price and income benefits from farm programs (or of some other type of financial assistance).

As a practical matter, new entrants to farming can probably survive with high land prices and high interest rates only if they are able to lease most of their land resources or arrange for a postponement of a portion of their "early year" debt repayment obligations.

Background Paper No. 6

Economic Effects of Selected Policies and Technology on the Economic Viability of General Crops Farms in the Delta Region of Mississippi

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Mississippi State University

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Office of Technology Assessment
U.S. Congress

This background paper was prepared for the assessment "Technology, Public Policy, and the Changing Structure of American Agriculture." The views expressed are those of the author(s) and not necessarily those of OTA.

Introduction

The purpose of this study was to analyze the impacts of selected farm commodity programs, federal income tax provisions, and farm-level production technologies on the economic viability of representative crop farms in the Delta Region of Mississippi. A number of alternative farm commodity price and income support programs, income tax provisions and technology scenarios were analyzed with respect to their impacts on the survival and growth of three representative general crops farms. Each representative farm produces cotton, rice, soybeans and wheat. The sizes of farms were selected to represent a moderate, large and very large farm in the region.

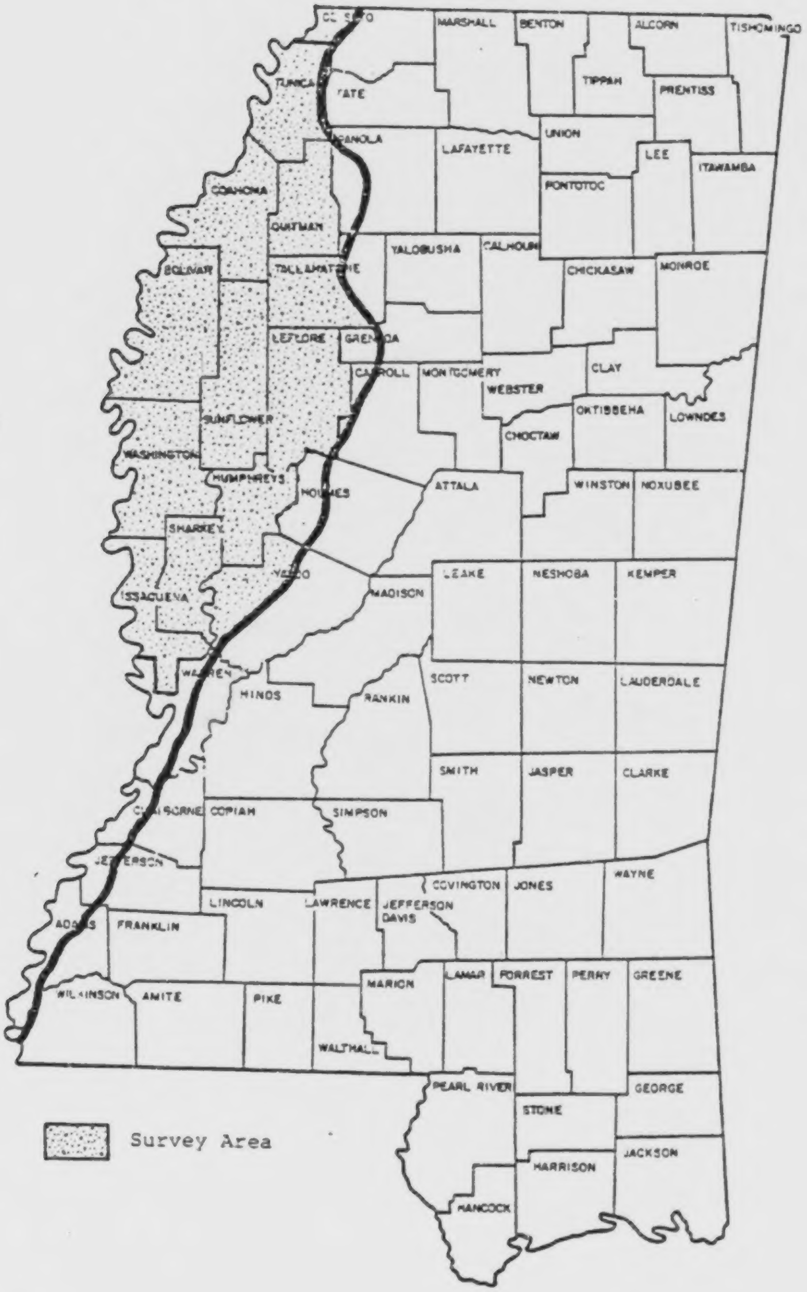
Method of Analysis

Two techniques were used to analyze the effects of the selected farm policy, income tax and technology provisions. A mail survey was used to obtain information on resource characteristics, acreages devoted to specific crops, and ASCS reported historic yields of crops receiving payment under the current farm program provisions. These data were used to develop resource characteristics of the three different sized representative farms. Then a whole farm simulation model was used to analyze the effects of alternative farm commodity policy, income tax, finance and technology advance scenarios on the economic viability and growth characteristics of each representative farm. The Farm Level Income Tax and Farm Policy Simulator (FLIPSIM V) model used in the farm simulations is described in detail by Richardson and Nixon (1).

Representative Farms

The mail survey was sent to all farms of 500 acres or more in size located in the Delta counties of Mississippi in the Fall of 1983 (Figure 1). A total of 116 respondents that produced all four crops on each farm was used in a cumulative frequency distribution analysis to group the farms into three distinct size categories. The "very large" farms approximate the largest 10 percent of farms from the survey, the "large" farms the 70th to 90th size percentiles and the "moderate size" farms the lowest 70th percentile of the 116 respondents with farms of 500 acres or more in size. The three representative farms used for this analysis represent the average characteristics of the farms in each size category. A total of 82 farms were in the size category of 500-2499 acres; 21 farms were in the size category of 2500-4499 acres; and the remaining 13 farms were in a size category of 4500 to slightly more than 10,000 acres. Information on the number of two-wheel drive tractors, 4-wheel drive tractors, combines, cotton pickers, managerial/supervisory workers, secretarial/office workers, shop workers, laborers/tractor drivers, acres planted to each crop in 1983 (including PIK acres), etc., was obtained from the mail survey. The three representative farms developed for this study are a moderate size farm (1443 acres);a large farm (3119 acres); and a very large farm (6184 acres).

Table 1 provides a summary of the financial and resource characteristics for the three representative farms. The proportion of cropland owned increases from 37% for the smallest farm to about 50% for the largest farm. The machinery and equipment complement was optimized for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LAMAR
FORREST
PERRY
GREENE
MARION
WILKINSON
AMITE
PIKE
WALTHALL
PEARL RIVER
GEORGE
STONE
JACKSON
HARRISON
HANCOCK
Survey Area

Figure 1. Farm Practices Survey Area in the Delta Region of Mississippi

Table 1. Financial and resource characteristics for three representative general crops farms in the Delta of Mississippi, 1983

Characteristics	Farm Size (acres)		
	1443	3119	6184
Age of farm operator[a]	44	44	44
Family size[a]	4	4	4
Cropland acres owned	533	1419	3064
Cropland acres leased	910	1700	3120
Acreage of principal crops in 1983			
Cotton	395	1088	2250
Rice	305	574	871
Soybeans	640	1190	2539
Wheat (or other small grains)	82	247	180
Value of owned cropland ($1,000)	799.5	2128.5	4596.0
Value of farm machinery ($1,000)	378.9	786.7	1209.8
Value of off-farm investments ($1,000)	129.1	210.3	358.7
Beginning cash reserve ($1,000)	31.9	71.1	141.6
Long-term debt ($1,000)	331.4	840.8	1640.8
Intermediate-term debt ($1,000)	243.8	413.0	574.7
Net worth ($1,000)	748.6	1921.5	4047.5
Total equity to assets (fraction)	0.56	0.60	0.64
Long-term debt/asset (fraction)	0.41	0.40	0.36
Intermediate-term debt/asset (fraction)	0.64	0.52	0.48
Off-farm income ($1,000)	18.3	18.2	36.0
Minimum family living expense ($1,000)	18.0	24.0	30.0
Maximum family living expense ($1,000)	27.0	36.0	45.0
Marginal propensity to consume (fraction)	0.25	0.25	0.25
Number of full-time hired employees	4	10	19

[a] Values for the age and family size variables assumed for the purpose of simulating the effects of alternative farm program provisions for the representative farms.

the crop acreages produced on each farm using crop budget performance rates per acre typical of the Delta of Mississippi. The market value of machinery and equipment for each farm reflects the 1982 market value of the budgeted machinery complement.

The long-term and intermediate-term debt to asset ratios for the 1443-acre farm and the 3119-acre farm were obtained from USDA's 1979 Agricultural Finance Survey (2) and adjusted to reflect the equity levels as reported from the 1983 mail survey of the 116 farms. These debt ratios are the average for part-owner general crops farms in the Mississippi Delta Region that had debt on real estate in 1979. Financial ratios for the largest farm were developed by extending the ratios on a per-acre basis for a 3457-acre farm as reported in the 1979 Agricultural Finance Survey and adjusted by the equity levels reported for the largest farm size group in the 1983 mail survey.

Average annual off-farm income adjusted to 1982 levels for the farms was obtained from the 1979 Agricultural Finance Survey. The off-farm income for the very large farm was the average of the amounts reported by eight of the 13 farm operators in this size category obtained through a telephone follow-up interview with these farmers. Maximum annual family living expenses were assumed to be $27,000 to $45,000, depending on farm size. A marginal propensity to consume disposable income of 0.25 was assumed, after the minimum family living expense was satisfied.

Costs of producing the four crops in the Delta of Mississippi were estimated by using the Mississippi State University Budget Generator and 1982 prices on all input items. The 1982 annual variable costs of production were assumed to be the same for the three representative farm sizes. Fixed expenses for machinery and equipment varies by farm size as the complement of machinery is different for each farm size.

The mix of acreages planted to each crop changes by farm size, as determined from the 1983 mail survey. In general, the acreage planted to cotton and soybeans increased relative to the acreage planted to rice and wheat as farm size increased. The 1443-acre farm planted 73% of tillable cropland to cotton and soybeans, while the 3119-acre farm and the 6184-acre farm planted 89% and 82%, respectively, of tillable cropland to cotton and soybeans. In the simulations, as the farm was allowed to grow in size to the next largest farm the proportion of cropland planted to each crop was changed to reflect these relative differences in crop mix.

Crop Yields and Prices

Crop yields from experimental plots in three Delta of Mississippi locations were used with ASCS reported yields for farm program payments to each of the mail survey respondents to develop a 10-year yield history for the representative farms. No statistically significant differences were found among the yields for each farm size category. Thus the same historical yield series was used for each representative farm. Estimated actual yields and prices for the representative farms are shown in Table 2.

The yields were used in an OLS trend regression to develop the multivariate empirical pdf described in Table 3. Judgments of the OTA commodity panels (3) regarding crop yield changes over the 1983-1992 period were used with the trend analysis to develop the annual mean

Table 2. Annual yields and prices for commodities produced on representative general crops farms in the Delta of Mississippi, 1974-1983.

Year	Cotton Lint	Cotton seed[a]	Rice	Soybeans	Wheat
			(Yield)		
	(lbs/acre)	(tons/acre)	(cwt/acre)	(bu/acre)	(bu/acre)
1974	691	0.54	50.78	21.1	24.9
1975	466	0.36	43.08	27.5	24.2
1976	461	0.36	47.63	23.6	29.8
1977	839	0.65	37.22	24.2	46.1
1978	908	0.70	41.57	24.8	39.5
1979	704	0.55	42.28	34.7	37.5
1980	540	0.42	38.83	17.0	34.1
1981	616	0.48	43.32	24.5	48.3
1982	1117	0.87	41.28	30.6	45.3
1983	657	0.51	41.47	21.6	40.4
			(Price)		
	($/lb)[b]	($/ton)[b]	($/cwt)[c]	($/bu)[d]	($/bu)[e]
1974	.500	97.00	10.10	7.51	3.42
1975	.497	97.00	9.10	4.55	2.62
1976	.619	110.00	6.56	6.07	3.46
1977	.528	77.00	8.12	6.25	2.03
1978	.615	124.00	7.56	6.35	2.90
1979	.613	134.00	9.81	6.51	4.10
1980	.769	134.00	10.40	8.25	3.57
1981	.569	80.00	10.90	6.20	3.19
1982	.601	61.00	7.60	5.41	3.16
1983	.661	165.00	8.48	8.06	3.50

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[a] Cottonseed is a linear function of lint yield, averaging 1.55 pounds of seed per pound of lint.

[b] Cotton lint and cottonseed prices are average cash prices in the Delta of Mississippi for the month of November.

[c] Rice prices are average cash prices for the Delta of Mississippi for the month of September.

[d] Soybean prices are average cash prices for the Delta of Mississippi for the month of November.

[e] Wheat prices are average cash prices for the Delta of Mississippi for the month of June.

yields over the period under the assumption of the most likely technology advances for each crop. Under this set of assumptions, mean cotton lint yields on farms in the Delta of Mississippi are expected to increase by 5% or about 4 pounds per acre annually through 1992. Rice yields are expected to increase by 9.2% or about 44 pounds per acre annually, while wheat yields are projected to increase by 26.6% or about 1.13 bushels per acre each year. The per acre yield of soybeans is projected to increase by 8.1% or about .23 bushel per acre annually. These most likely yield advances involve various sets of technologies such as: 1) variety improvement through genetic engineering, photosynthesis enhancement, and plant growth regulators, 2) improved management of crop pests, 3) biological nitrogen fixation and use of chemical fertilizers, 4) soil, water and crop management improvements, and 5) a host of other techniques including labor saving technologies, fuel savings, communications and information management, etc.

The annual deviations from the OLS trend regression for 1974-1983 yields were expressed as a fraction of their respective mean in 1983 and then sorted to develop the deviations presented in Table 3. A similar analysis was carried out to develop the 1983-1992 deviations from mean prices presented in Table 4. The correlations among yields and prices shown in Table 5 were estimated using the deviations about the OLS trend line for annual yields and prices for the 1974-1983 period. All prices were deflated to 1982 levels by the Index of Prices Paid by Farmers prior to fitting the trend line.

Capital Costs

Annual interest rates on existing debt for land, machinery and operating loans were 9%, 12.5% and 15%, respectively. Interest rates

Table 3. Annual means and probability distributions for yields used in simulations for representative general crops farms in the Delta of Mississippi

Year	Cotton Lint	Cotton seed	Rice	Soybeans	Wheat
	------------- Annual mean yields used for analysis-----------				
	(lbs/acre)	(tons/acre)	(cwt/acre)	(bu/acre)	(bu/acre)
1983	699.90	0.54	42.75	24.96	37.01
1984	703.80	0.55	43.19	25.19	38.14
1985	707.80	0.55	43.63	25.42	39.27
1986	711.70	0.55	44.07	25.66	40.41
1987	715.70	0.55	44.51	25.89	41.54
1988	719.60	0.56	44.95	26.12	42.68
1989	723.50	0.56	45.39	26.35	43.82
1990	727.50	0.56	45.83	26.58	44.95
1991	731.40	0.57	46.26	26.81	46.08
1992	735.40	0.57	46.70	27.04	47.21
	------------ Deviations from mean yields (fraction)[a/]----------				
1983	-.279	[b/]	-.153	-.326	-.163
1984	-.256		-.068	-.155	-.160
1985	-.215		-.048	-.134	-.150
1986	-.214		-.035	-.043	-.075
1987	-.205		-.003	-.030	-.055
1988	-.011		.021	-.024	-.015
1989	.140		.042	-.004	.028
1990	.250		.053	.118	.095
1991	.314		.074	.210	.165
1992	.477		.116	.388	.330

[a/] Deviations from a simple trend regression for 1974-1983 data expressed as a fraction of their respective means in 1983 and then sorted to develop the deviations shown.

[b/] Cottonseed is perfectly correlated to lint inside the model.

Table 4. Annual means and probability distributions for prices used in simulations for representative general crops farms in the Delta of Mississippi.

Year	Cotton lint	Cotton seed	Rice	Soybeans	Wheat
	--------- Annual mean prices used for analysis[a/] ---------				
	($/lb)	($/ton)	($/cwt)	($/bu)	($/bu)
1983	0.69	111.75	10.14	6.66	3.95
1984	0.67	109.07	9.74	6.49	3.48
1985	0.65	106.47	9.50	6.34	3.39
1986	0.65	106.47	9.50	6.34	3.39
1987	0.65	106.47	9.50	6.34	3.39
1988	0.65	106.47	9.50	6.34	3.39
1989	0.65	106.47	9.50	6.34	3.39
1990	0.65	106.47	9.50	6.34	3.39
1991	0.65	106.47	9.50	6.34	3.39
1992	0.65	106.47	9.50	6.34	3.39
	-------- Deviations from mean prices (fraction)[b/] -------				
1983	-.164	-.490	-.360	-.409	-.394
1984	-.114	-.381	-.170	-.186	-.180
1985	-.069	-.344	-.104	-.138	-.082
1986	-.056	-.044	-.083	-.061	-.080
1987	-.028	.023	.053	-.048	-.034
1988	-.021	.114	.054	-.008	.025
1989	.047	.149	.060	.004	.099
1990	.084	.239	.098	.180	.161
1991	.151	.256	.151	.244	.233
1992	.171	.478	.302	.421	.251

[a/] Prices are expressed in real 1982 dollars.

[b/] Deviations from a simple OLS trend regression for 1974-1983 data expressed as a fraction of their respective means in 1983 and then sorted to develop the deviations shown.

Table 5. Correlation of yields and prices for representative general crops farms in the Delta of Mississippi[a]

	Cotton lint Yield	Cotton Seed Yield	Rice Yield	Soybean Yield	Wheat Yield	Cotton lint Price	Cottonseed Price	Rice Price	Soybean Price	Wheat Price
Cotton lint yield	1.0	.999	-.166	.374	.523	-.228	-.421	-.154	-.007	-.246
Cottonseed yield		1.0	-.156	.378	-.520	-.231	-.426	-.149	-.003	-.235
Rice yield			1.0	-.023	-.405	-.009	.160	.196	.309	.779
Soybean Yield				1.0	.208	-.482	-.213	-.178	-.609	.028
Wheat yield					1.0	-.399	-.604	-.218	-.185	-.616
Cotton lint price						1.0	.637	-.422	.453	.368
Cottonseed price							1.0	.002	.437	.545
Rice price								1.0	.381	.204
Soybean Price									1.0	.483
Wheat price										1.0

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a/ The correlation matrix was estimated using deviations about a simple OLS trend line for annual yields and prices, 1974-1983. Prices were deflated to a 1982 = 100 base using the Index of Prices Paid by Farmers prior to fitting the trend line.

for new debts on land were 11.5% annually and refinancing of long-term real estate loans was allowed at interest rates of 13% annually. Similarly, new loans for machinery were at a 13.5% annual interest rate, with refinancing of intermediate-term loans allowed at a 14.5% annual interest rate. Cash reserves were assumed to earn 9.5% interest annually and off-farm investments earned 10% interest annually.

The representative farms were permitted to grow at the end of each year by leasing cropland, or purchasing cropland if the operator had cash available (after meeting all expenses) to cover a 30% down payment for land, and a 20% down payment for any additional machinery purchases required to operate the proposed larger farm. Growth in farm size also required hiring of additional labor to operate the larger unit.

Policy and Technology Scenarios

The three representative general crops farms were simulated over a 10-year period (1983-1992) for a total of fourteen alternative scenarios. These included seven alternative farm commodity program - income tax provision scenarios, one alternative income tax scenario, three financial stress scenarios, and three alternative technology scenarios. In addition, the moderate size farm was simulated under the conditions of a new entrant into farming for three alternative farm commodity program - income tax provision scenarios. All assumptions regarding policy values for each scenario were the same for each representative farm to allow comparisons of their impacts on different sized farms. Each scenario is described in detail in the following sections of this report.

Farm Policy Scenarios

I. Base Policy -- The Base Policy Scenario involves continuation of the 1981 Farm Bill through 1992 and continuation of the income tax provisions under TEFRA through 1992. In addition, annual mean crop yields that were projected under the most likely technology advance alternative (Table 3) were used in the simulations. For this scenario it is assumed the following farm policies were in effect.

1) The CCC loan program is available to producers for cotton, rice, soybeans and wheat.
2) A 3-year indirect farmer owned reserve (FOR) is available for wheat.
3) An acreage diversion/set aside program is in effect for cotton, rice and wheat during 1983-1985, using the actual acreage reduction levels and diversion payment rates specified for these years.
4) A target price-deficiency payment program is available for cotton, rice and wheat in all years.
5) The $50,000 payment limitation for deficiency and diversion payments is in effect.
6) Farms of all sizes are eligible to participate in these farm program provisions.

Values for loan rates, target prices, diversion rates, and diversion payment rates for 1983 and 1984 are set at their actual values expressed in constant 1982 dollars. Values for these variables for 1985 are set at their respective levels announced on or before September 14, 1984 by the Secretary of Agriculture. Loan rates and target prices for 1985 are held constant through 1992. No acreage reduction program was assumed to be in effect after 1985. Historical national loan rates, target prices (except for soybeans), acreage set aside/diversion rates and diversion payment rates for program compliance over the 1977-1985 period are presented in Table 6. All dollar values in Table 6 are expressed in current dollars. The average relationship between real loan rates and real prices for 1977-1982 was computed for each commodity and used to estimate the real average annual prices shown in Table 4 that were used in the 1983-1992 simulations. (This was done to minimize the bias caused by setting mean prices too close to either the loan rate or the target price.) The loan rates and target prices, expressed in constant 1982 dollars and adjusted for grade and quality factors for the Delta of Mississippi are presented in Table 7.

It was assumed the following options for depreciating machinery and calculating income taxes are used for the Base Policy Scenario.

1) Machinery, livestock, and buildings placed in use prior to 1981 are depreciated using the double declining balance method.
2) Machinery, livestock, and buildings placed in use after 1980 are depreciated using an accelerated cost recovery method.
3) The farm operator elects to claim first year expensing for all depreciable items placed into use after 1980.
4) The farm operator elects to take maximum investment tax credit (ITC) and thus reduce the basis for all depreciable assets placed into service after 1980.
5) The farm operator adjusts crop sales across tax years to reduce current year taxes.
6) The farm operator may use either the regular income tax computation or income averaging to calculate federal income tax liabilities.

Table 6. National loan rates, target prices and acreage set aside/diversion rates for cotton, rice, wheat and soybeans, 1977-1985

Year	Loan rate	Target price	Set aside rate	Diversion	Diversion payment rate
			Cotton		
	($/lb)	($/lb)	(%)	(%)	($/lb)
1977	.4463	.4780			
1978	.4800	.5200			
1979	.5023	.5770			
1980	.4800	.5840			
1981	.5246	.7087			
1982	.5708	.7100	15	0	.00
1983	.5500	.7600	20	5	.25
1984	.5500	.8100	25	0	.00
1985	.5500	.8100	20	5	.25
			Rice		
	($/cwt)	($/cwt)	(%)	(%)	($/cwt)
1977	6.19	8.25			
1978	6.40	8.53			
1979	6.79	9.05			
1980	7.12	9.49			
1981	8.01	10.68			
1982	8.14	10.85	15	0	.00
1983	8.14	11.40	15	5	
1984	8.00	11.90	20	5	.00
1985	8.00	11.90	20	15	3.50
			Wheat		
	($/bu)	($/bu)	(%)	(%)	($/bu)
1977	2.25	2.90			
1978	2.35	3.40			
1979	2.50	3.40			
1980	3.30	3.63			
1981	3.50	3.81			
1982	4.00[a]	4.05	15	0	.00
1983	3.65	4.30	15	5	2.70
1984	3.30	4.38	20	10	2.70
1985	3.30	4.38	20	10	2.70
			Soybeans		
	($/bu)	b/	b/	b/	b/
1977	3.50				
1978	4.50				
1979	4.50				
1980	5.02				
1981	5.02				
1982	5.02				
1983	5.02				
1984	5.02				
1985	5.02				

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a/ Farmer Owned Reserve entry price in 1982 exceeded the $3.55/bu. loan rate for wheat.

b/ Soybeans have been under a loan program only with no target price/deficiency payment program or acreage set aside/diversion provisions.

Table 7. Localized loan rates and target prices for a general crops farm in the Delta of Mississippi[a/]

Year	Cotton lint		Rice		Soybeans	Wheat	
	Loan rate	Target price	Loan rate	Target price	Loan rate	Loan rate	Target price
	($/lb)	($/lb)	($/cwt)	($/cwt)	($/bu)	($/bu)	($/bu)
1983	.55	.75	8.54	11.97	4.89	3.53	3.92
1984	.53	.78	8.21	12.20	4.77	3.11	4.06
1985	.52	.76	8.00	11.91	4.66	3.03	4.03
1986	.52	.76	8.00	11.91	4.66	3.03	4.03
1987	.52	.76	8.00	11.91	4.66	3.03	4.03
1988	.52	.76	8.00	11.91	4.66	3.03	4.03
1989	.52	.76	8.00	11.91	4.66	3.03	4.03
1990	.52	.76	8.00	11.91	4.66	3.03	4.03
1991	.52	.76	8.00	11.91	4.66	3.03	4.03
1992	.52	.76	8.00	11.91	4.66	3.03	4.03

[a/] Loan rates and target prices in effect for 1983-1984 and announced for 1985 were deflated to 1982 real dollars. These values were localized for the typical grade or quality of crop marketed in the Delta Region of Mississippi in 1982-1983.

7) There is no maximum interest deduction for calculating taxable income.

8) The actual self employment tax rates and maximum income levels subject to this tax for 1983 and 1984 are used. Announced values for these variables in 1985-1986 were used and the 1986 values were held constant through 1992.

9) The farm operator elects to trade-in old machinery on new replacements at the end of each item's economic life.

II. A 20% Acreage Reduction -- The provisions of the Base Policy Scenario were modified by adding a 15% set aside with a 5% diversion for cotton, rice and wheat in 1986-1992. Normal slippage of 70% for each of the crop and program participation rates were used to estimate the resulting real increase in mean prices for these crops in 1986-1992. All other provisions of the Base Policy Scenario were used without change.

III. No Farm Program Payment Limitation -- All provisions of the Base Policy Scenario were used except that the $50,000 limitation on diversion and deficiency payments was removed.

IV. No Price Supports and No Diversion Payments -- The CCC loan, FOR, and target price provisions under the Base Policy Scenario were assumed to have been eliminated for all years in the 1983-1992 planning horizon. Annual mean prices for all crops were decreased based on the new expected value of their respective probability distributions. Relative variability in prices about their means was increased based on the work of Morton, Devadoss, and Heady (4) as to the effects of no farm program on U.S. agriculture. Since all other provisions of the Base Policy Scenario were left intact, the acreage diversion and set aside programs in place for 1983-1985 were assumed to remain in effect.

V. No Target Price/Deficiency Payment -- The target price and deficiency payment program was assumed to be eliminated for all years of the 1983-1992 planning horizon. All other provisions of the Base Policy Scenario were used without change.

VI. Target Farm Program Benefits -- All farm program and income tax provisions of the Base Policy Scenario were used except that farms producing more than $300,000 of program commodities (cotton, rice, soybeans and wheat) valued at their localized loan rate were not permitted to participate directly in the program provisions (CCC loan, FOR, target price/deficiency payments, and set aside-diversions). Mean prices and relative variability in prices were not adjusted because sufficient numbers of farms with less than $300,000 of program commodity sales were assumed to participate in the farm program for the price support provisions of the CCC loan and FOR to function normally.

VII. No Farm Program -- All farm program provisions outlined for the Base Policy Scenario were eliminated for all 10 years of the planning horizon. Mean annual prices and relative variance in prices for the No Price Supports and No Diversion Payments Scenario (IV) were used due to eliminating provisions of the CCC loan and FOR reserve under this scenario.

Income Tax Scenario

VIII. Reduced Income Tax Benefits and Base Policy Program -- The federal income tax provisions in place for the Base Policy Scenario were made more restrictive. All farm policy provisions of the Base Policy

Scenario were left unchanged. The more restrictive federal income tax provisions included:

1) Machinery, livestock, and buildings were depreciated using the straight line cost recovery method.

2) First year expensing provisions were eliminated for all depreciable items.

3) Maximum investment tax credit (ITC) provisions were eliminated.

4) The maximum annual interest expense which could be used to reduce taxable income was $15,600.

5) The farm operator must sell obsolete machinery upon disposition rather than trading it in on new replacements, thus forcing recapture of excess depreciation deductions.

All other federal income tax provisions for the Base Policy Scenario were used as outlined earlier.

Financial Stress Scenarios

IX. Base Finance Scenario -- Each farm's long-term debt to asset ratio was increased to 0.55 and its intermediate-term debt to asset ratio was increased to 0.60 to represent a highly leveraged farm. (If the farm's intermediate-term debt to asset ratio exceeded 0.60 based on the 1979 Ag Finance Survey, the greater value was used.) Annual long- and intermediate-term interest rates were increased to their average values (.1139 and .1343, respectively) for 1980-1983 to represent a farm which had been forced to refinance its assets during the past four years. These same interest rates were used for all three financial stress scenarios. The farm program provisions associated with the Base Policy Scenario were used for all three financial stress scenarios.

X. Debt Restructure -- The length of intermediate-term loans was increased 1 year, to 7 years, and a portion of intermediate debt was converted to long-term debt. The conversion of intermediate-term debt to long-term debt was not permitted to increase the long-term debt to asset ratio above 0.65. For each of the representative farms this constraint substantially restricted debt conversion. Annual interest rates, total debt loads, and farm program provisions were the same as those used for the Base Finance Scenario (IX).

XI. Interest Subsidy -- The annual interest rates, debt levels, and farm program provisions in the Base Finance Scenario (IX) were simulated but an interest subsidy was provided during the first two years. The interest subsidy took the form of an interest rate reduction equal to 3.4 percentage points for long-term interest rates and 5.4 percentage points for intermediate-term interest rates. These interest rate reductions were the amounts necessary to reduce their respective interest rates (.1137 and .1343) to a 4% real rate assuming a 4% annual inflation rate.

No New Technology Scenarios

XII. No New Technology and Base Farm Policy -- The federal income tax and farm program provisions in the Base Policy Scenario (I) were simulated assuming that no new technology would be introduced during the 1983-1992 period. For the Delta of Mississippi Region, mean annual yields were not expected to increase in the absence of any new technology being developed and adopted. Without new technology, existing knowledge and techniques would be adequate to only maintain the yield levels that have already been achieved in the region. Thus the mean annual yields for 1974-1983 were used in all three of the No New

Technology Scenarios. For these scenarios, mean yields for each year through 1992 for cotton, soybeans, wheat and rice were those shown for 1983 in Table 3. Since the simulation analysis was stochastic, however, the actual yields (and prices) were drawn randomly (within the simulation model) from the sample of yields presented in the historical data (1974-1983) in Table 2.

XIII. No New Technology and No Deficiency Payments -- The farm program provisions in the No Target Price/Deficiency Payments Scenario (V) were simulated assuming mean annual crop yields used in the No New Technology and Base Farm Policy Scenario (XII).

XIV. No New Technology and No Farm Program -- All farm program provisions were eliminated (Scenario VII) and mean annual crop yields used in the No New Technology and Base Farm Policy Scenario (XII) were used.

New Entrant Scenarios

XV. New Entrant and Base Farm Policy -- The farm policy provisions of the Base Policy Scenario (I) were evaluated assuming the farm operator on the moderate size farm was a new entrant. The farm operator was assumed to have the minimum equity in land (30%) and farm machinery (35%). All farm machinery was considered to have a 1982 new machinery cost. Annual interest rates for long-term and intermediate term loans were set at the average 1980-1983 interest rates. No-off farm investments or off-farm income was allowed. These assumptions regarding the farm operator's initial debt-asset position and sources of income were used for all three new entrant scenarios. The farm operator was assumed to be purchasing 533 acres of cropland and leasing 910 acres. Because the farm operator was paying the full cost of all inputs (land, capital, machinery, and labor) this scenario provides an indication of the long-run survivability of the representative farm under conditions of continuing the current farm policy and income tax provisions and conditions of the most likely technology advance scenarios.

XVI. New Entrant and No Deficiency Payments -- The farm program provisions in the No Target Price/Deficiency Payments Scenario (V) were simulated under the conditions that the farm operator was a new entrant to farming.

XVII. New Entrant and No Farm Program -- All farm commodity program provisions as in Scenario VII were eliminated during all years of the planning horizon for this scenario.

Evaluation Criterion

The FLIPSIM V model provides considerable detail as to the viability of a representative farm at the end of each iteration, e.g., ending leverage ratio, ending net worth, ending farm size, total assets, total debt, net present value, and whether the farm remained solvent for 10 years. By repeating each scenario for 50 iterations, the model generates the information necessary to estimate the probability distributions for key output variables. The means of these key output distributions are used to compare the economic impacts of selected policy and technology scenarios on representative farms. The following output variables for the model were used to assess the impacts of the scenarios described in the previous section.

1) Probability of survival -- Defined as the probability that the representative farm will remain solvent for 10 years. It is the probability that the farm operator would maintain at least

the minimum financial ratios (30% equity in land and 35% equity in farm machinery) for each of the 10 years of the planning horizon.

2) Probability of a positive net present value -- The probability that the representative farm will have a positive after-tax net present value. An after-tax, real discount rate of 3% was used to calculate the farm's net present value. This statistic indicates the probability of the representative farm providing at least a 3% real rate of return to the operator's initial net worth.

3) After-tax net present value (NPV) -- The present value of the operator's annual cash withdrawals (CW) plus the present value of the change in net worth (NW) minus the present value of annual off-farm income (OY):

$$NPV = \sum_{t=1}^{T} \frac{CW_t - OY_t}{(1.03)^t} + \frac{NW_T}{(1.03)^T} - NW_o$$

Cash withdrawals equal family living expenses plus state and federal income taxes and self-employment taxes. Initial net worth (NW_o) and ending new worth (NW_T) explicitly consider the value of off-farm investments and accrued taxes. A 3% after-tax, real discount rate was used to calculate net present value for all representative farms.

4) Present value of ending net worth -- Indicates the change in the real net worth of the farm over the planning horizon. Net worth is affected by increases or decreases in the value of

land and machinery assets and by retained earnings. This value can be compared directly to the initial net worth of the farm given in Table 1 to indicate the relative magnitude of real financial growth.

5) Acres owned, leased, and controlled at the end of the planning horizon -- For each iteration these statistics indicate the impacts of the alternative scenarios on growth in land resources for the representative farms. These three statistics provide an indication of how the farm increased acreage, either by purchasing or leasing land. Also, they indicate whether the farm was forced to sell cropland to remain solvent.

6) Total long- and intermediate-term debts at the end of the planning horizon -- The two measures provide an insight into the financial stress of the farm over the planning horizon. Increases in average ending debt from one scenario to another can be due to either rapid growth through purchasing land and machinery or the farm operator being forced to refinance large cash flow deficits. When surplus cash is available, the operator is permitted to first prepay intermediate-term debts and then prepay new long-term debts. Therefore large ending intermediate-term debts indicate insufficient cash was available to reduce intermediate-term debt through prepayment of principal.

7) Ending equity ratio -- The farm's ending ratio of total net worth to total assets. This ratio provides a "bottom-line" measure for comparing the representative farm's ending financial position across scenarios.

8) Internal rate of return -- For the representative farm this measure is calculated at the end of each iteration. The internal rate of return is the discount rate which makes the present value of the operator's annual cash withdrawals and change in net worth equal zero. The variables outlined above for the net present value formula are used to calculate internal rate of return.

9) Average annual net farm income -- The net farm income received by the farm operator averaged over all years simulated. Net farm income equals total farm receipts plus total government payments minus all cash production expenses, interest payments, labor costs, fixed costs (excluding principal payments), and depreciation. This value excludes all non-farm income and interest earned on cash reserves.

10) Average annual government payment -- The annual government payments (deficiency and diversion payments) to the farm operator averaged over all years simulated.

Simulation Results

Farm Commodity Policy and Income Tax Alternatives

The results from simulating the effects of the seven alternative farm commodity policy scenarios and the alternate income tax provisions on the three representative farms in the Delta of Mississippi Region are presented in Tables 8, 9, and 10. Under the provisions of these eight policy alternatives each representative farm had a 100% probability of survival in that equity in land and machinery did not fall below 30% and 35%, respectively. One of the principal reasons for the solvency of these farms over the 10-year planning horizon was the availability of off-farm income to meet some of the cash flow needs.

Table 8. Comparison of selected farm commodity and income tax policy scenarios for a representative 1443-acre general crop farm in the Delta of Mississippi

Criteria	Initial Situation	Alternative Scenarios[a]							
		I	II	III	IV	V	VI	VII	VIII
Probability of survival (%)	--	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	--	100	100	100	100	100	100	98	60
After-tax net present value ($1,000)	--	1090.3	1188.4	1408.7	383.7	425.1	335.6	346.6	1203.9
Average present value of ending net worth ($1,000)	748.6	1650.8	1757.3	1880.7	1105.5	1134.0	1058.7	1069.7	1532.9
Average ending cropland owned (acres)	533.0	651.4	709.0	801.8	533.0	539.4	533.0	533.0	555.4
Average ending cropland leased (acres)	910.0	1358.0	1348.4	1290.8	1092.4	1105.2	1047.6	1057.2	1358.0
Average ending cropland controlled (acres)	1443.0	2009.4	2057.4	2092.6	1625.4	1644.6	1580.6	1590.2	1913.4
Average ending long-term debts ($1,000)	331.4	218.7	270.5	354.5	135.3	123.9	154.3	170.7	130.8
Average ending intermediate-term debts ($1,000)	243.8	40.2	63.1	36.8	89.7	90.4	101.5	91.1	13.0
Average ending equity ratio (fraction)	0.56	0.88	0.86	0.83	0.86	0.87	0.84	0.84	0.89
Average internal rate of return (fraction)	--	0.11	0.11	0.13	0.05	0.06	0.05	0.05	0.13
Average annual net farm income ($1,000)	--	38.9	40.4	64.6	-14.2	-6.9	-16.3	-17.6	29.9
Average annual government payment ($1,000)	--	48.2	45.2	75.4	1.9	1.9	1.9	0.0	47.9

[a] The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Supports and No Diversion Payments in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

Table 9. Comparison of selected farm commodity and income tax policy scenarios for a representative 3119-acre general crop farm in the Delta of Mississippi

Criteria	Initial Situation	Alternative Scenarios[a]							
		I	II	III	IV	V	VI	VII	VIII
Probability of survival (%)	--	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	--	100	100	100	100	100	100	100	100
After-tax net present value ($1,000)	--	1232.8	1645.4	3146.0	656.0	731.3	592.1	620.1	2070.8
Average present value of ending net worth ($1,000)	1921.5	2940.1	3279.8	4418.0	2482.2	2537.4	2432.5	2453.7	3138.8
Average ending cropland owned (acres)	1419.0	1431.8	1451.0	1777.4	1419.0	1425.4	1419.0	1419.0	1419.0
Average ending cropland leased (acres)	1700.0	1895.2	1888.8	2100.0	1700.0	1709.6	1700.0	1700.0	1716.0
Average ending cropland controlled (acres)	3119.0	3327.0	3339.8	3877.4	3119.0	3135.0	3119.0	3119.0	3135.0
Average ending long-term debts ($1,000)	840.8	134.0	137.0	342.1	191.3	157.8	197.7	218.7	273.8
Average ending intermediate-term debts ($1,000)	413.0	255.3	189.2	5.2	251.8	276.8	279.7	252.1	225.9
Average ending equity ratio (fraction)	0.60	0.89	0.90	0.89	0.87	0.87	0.86	0.87	0.85
Average internal rate of return (fraction)	--	0.07	0.08	0.12	0.04	0.05	0.04	0.04	0.10
Average annual net farm income ($1,000)	--	38.3	65.1	148.0	-20.6	- 8.2	-28.9	-25.1	21.8
Average annual government payments ($1,000)	--	49.9	49.1	160.6	4.7	4.8	0.0	0.0	49.9

[a] The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Diversion Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

Table 10. Comparison of selected farm commodity and income tax policy scenarios for a representative 6184-acre general crop farm in the Delta of Mississippi

Criteria	Initial Situation	Alternative Scenarios[a]							
		I	II	III	IV	V	VI	VII	VIII
Probability of survival (%)	--	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	--	100	100	100	100	98	98	100	100
After-tax net present value ($1,000)	--	1619.6	2465.4	4742.5	1182.6	1267.8	966.9	1108.9	3139.4
Average present value of ending net worth ($1,000)	4047.5	5449.6	6116.2	7728.0	5135.0	5175.2	4964.2	5078.9	5901.6
Average ending cropland owned (acres)	3064.0	3121.6	3112.0	3294.4	3092.8	3102.4	3096.0	3102.4	3076.8
Average ending cropland leased (acres)	3120.0	3126.4	3142.4	3235.2	3177.6	3142.4	3145.6	3164.8	3126.4
Average ending cropland controlled (acres)	6184.0	6248.0	6254.4	6529.6	6270.4	6244.8	6241.6	6267.2	6203.2
Average ending long-term debts ($1,000)	1640.8	106.4	57.3	110.9	144.2	129.0	173.5	227.0	261.0
Average ending intermediate-term debts ($1,000)	574.7	456.4	381.9	120.0	383.3	466.0	465.0	409.2	354.5
Average ending equity ratio (fraction)	0.64	0.91	0.92	0.94	0.91	0.91	0.90	0.90	0.89
Average internal rate of return (fraction)	--	0.05	0.06	0.10	0.04	0.04	0.04	0.04	0.08
Average annual net farm income ($1,000)	--	41.9	118.2	277.1	-19.7	-0.6	-42.9	-32.4	5.9
Average annual government payments($1,000)	--	49.8	49.8	278.0	7.9	0.0	0.0	0.0	49.9

[a] The scenarios are:
I -- Base Policy or continuation of the 1981 Farm Bill and 1983 federal income tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Diversion Payment in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and the Base Farm Program.

Each of the representative farms exhibited a very high probability (98% to 100%) of having a positive after-tax net present value under all policy scenarios involving eligibility for government program payments. Only the policy scenario with no farm income or price support (Scenario VII) for the 1443-acre farm and the policy scenarios with no target prices and deficiency payments (Scenario V) or targeting of farm program benefits to farms producing less that $300,000 in program crops (Scenario VI) for the 6184-acre farm exhibited a probability of having a positive after-tax net present value below 100% (Tables 8-10).

The remaining criteria in Tables 8-10 are indicative of farm size, wealth and financial characteristics that are projected to occur on these representative farms over the 10-year simulation under each policy alternative. Rates of change (expressed as percentages from initial levels) in the values of these variables are presented in Table 11 for each of the representative farms.

The present value of ending net worth is one measure of real wealth accumulation. In interpreting these values in Table 11, two revealing features are noticeable. First, as one compares the eight policy scenarios for each size of farm, substantial greater growth in real net worth occurs on the representative farms under conditions that continue current farm commodity policy and income tax provisions with and without acreage reductions and farm program payments limitation (Scenario I-III) and with a more restrictive set of income tax provisions (Scenario VIII). For the 1443-acre farm real net worth increases by some 105% to 151% under these program alternatives. The largest rate of growth in real net worth (a 151% increase from the initial situation) occurs for the alternative that continues the 1981 Farm Bill provisions, but with

Table 11. Rates of change in selected farm size, wealth and financial characteristics under alternative farm commodity and income tax policy scenarios for representative general crops farms in the Delta of Mississippi

Criteria	Initial Situation	Percentage change in variable level from initial situation for alternative scenarios[a]							
		I	II	III	IV	V	VI	VII	VIII
		1443-acre farm							
Present value of ending net worth ($1,000)	748.6	120	135	151	48	51	41	43	105
Cropland owned after 10 years (Acres)	533.0	22	33	50	0	1	0	0	4
Cropland leased after 10 years (acres)	910.0	49	48	42	20	21	15	16	49
Total cropland controlled after 10 years (acres)	1443.0	39	43	45	13	14	10	10	33
Total long-term debts after 10 years ($1,000)	331.4	-34	-18	7	-59	-63	-53	-48	-61
Total intermediate-term debts after 10 years ($1,000)	243.8	-84	-74	-85	-63	-63	-58	-63	-95
Total equity to asset ratio after 10 years (%) [b]	56.0	88	86	83	86	87	84	84	89
		3119-acre farm							
Present value of ending net worth ($1,000)	1921.5	53	70	130	29	32	27	28	63
Cropland owned after 10 years (acres)	1419.0	1	2	25	0	<1	0	0	0
Cropland leased after 10 years (acres)	1700.0	11	11	24	0	<1	0	0	1
Total cropland controlled after 10 years (acres)	3119.0	7	7	24	0	<1	0	0	<1
Total long-term debts after 10 years ($1,000)	840.8	-84	-84	-59	-77	-81	-76	-74	-67
Total intermediate-term debts after 10 years ($1,000)	413.0	-38	-54	-99	-39	-33	-32	-40	-45
Total equity to asset ratio after 10 years (%) [b]	60.0	89	90	89	87	87	86	87	85
		6184-acre farm							
Present value of ending net worth ($1,000)	4047.5	35	51	91	27	28	23	25	46
Cropland owned after 10 years (acres)	3064.0	2	2	8	<1	1	1	1	<1
Cropland leased after 10 years (acres)	3120.0	<1	<1	4	2	<1	<1	1	<1
Total cropland controlled after 10 years (acres)	6184.0	1	1	6	1	< 1	< 1	1	< 1
Total long-term debts after 10 years ($1,000)	1640.8	-93	-96	-93	-91	-92	-89	-86	-84
Total intermediate-term debts after 10 years ($1,000)	547.7	-21	-34	-79	-33	-19	-19	-29	-38
Total equity to asset ratio after 10 years (%) [b]	64.0	91	92	94	91	91	90	90	89

[a] The scenarios are:
I -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions.
II -- A 20% Acreage Reduction in 1986-1992.
III -- No Farm Program Payment Limitation in 1983-1992.
IV -- No Price Support and No Diversion Payments in 1983-1992.
V -- No Target Price/Deficiency Payment in 1983-1992.
VI -- Target Farm Program Benefits to farms that produce less than $300,000 in program crops.
VII -- No Farm Program in 1983-1992.
VIII -- Reduced Income Tax Benefits and continuation of the 1981 Farm Bill.

[b] Values for all policy scenarios represent the percent equity in total assets after 10 years not the percentage changes in these equity to asset ratios.

no farm program payments limitations (Scenario III). A policy that continues the current farm program but with a 20% acreage reduction in 1986-1992 results in a 135% growth in real net worth. Much lower growth rates in real net worth occur for the policy alternatives that eliminate various provisions of the current farm program, withdraws all farm program support, or targets the benefits to farms producing less than $300,000 of program crops. Similar patterns are evident in the effects of the policy alternatives on rates of growth in real net worth of the 3119-acre farm and the 6184-acre farm.

The second noticeable pattern in Table 11 is the decline in the growth rate in real wealth as the size of the representative farm increases from the 1443-acre farm to the 6184-acre farm for each of the policy alternatives. Comparisons among the different farm sizes must be made with caution because the initial total equity to asset ratios differ. However, the results indicate that the policy alternatives involving farm program payments (Scenarios I-III and Scenario VIII) induced a greater growth rate in real wealth on the moderate size farm as compared with the two larger farms.

This pattern of growth is even more evident when one examines changes in farm acreage. The 1443-acre farm experienced considerable growth in both owned land acreage and/or acreage leased under Scenarios I-III and Scenario VIII. In contrast the two larger farms exhibited less than 7% growth in farm size under these scenarios, with the exception of the 3119-acre farm under Scenario III wherein payments limitations are removed. The 1443-acre farm experienced a 10% to 14% increase in acreage whereas the two larger farms exhibited virtually no growth in farm acreage for the policy alternatives involving elimination of some or all the program payments provisions and when program payments are targeted to farms with less than $300,000 of program commodity sales. These results indicate that farm program payments are an important inducement to growth of moderate size general crops farms in the Delta of Mississippi Region.

The two largest representative farms reduced a substantial portion of the long-term real estate debt under all scenarios. The 1443-acre farm had a much lower rate of long-term debt pay-back, principally because growth in farm size occurred through purchase of additional cropland under Scenarios I-III, and the use of accumulated cash to purchase machinery and equipment for expansion on leased land under Scenarios IV-VIII. The 1443-acre farm generally exhibited a larger liquidation of its intermediate-term debt than the two larger farms for each of the policy alternatives. Each of the representative farms tended to use income from both farm and non-farm sources to pay back existing debts, and the ratio of total equity to total assets increased appreciably on each farm for all of the policy alternatives.

The three representative general crops farms in the Delta of Mississippi Region are much dependent on farm program payments in maintaining net farm income. This dependency is revealed in Tables 8, 9, and 10. When one examines the average annual net farm incomes and average annual total government program payments over the 10 years, the policy alternatives involving relatively little or no government payments (Scenarios IV-VII) resulted in negative average annual net farm incomes.

Summary of Results from Policy Simulations

All three representative farms had a 100% chance of remaining solvent (i.e., equity levels in land and machinery remained above 30% and 35%, respectively) over the 10-year planning horizon.

The probability of having a positive after-tax net present value over the 10 years was 100% for the 1443-acre farm and for the 3119-acre farm for all policy alternatives involving farm program government payments; however, the probability of having a positive net present value over the 10 years was 98% on the 6184-acre farm for the No Target Price/Deficiency Payment Scenario (V) and the policy involving targeting of farm program benefits to farms with less than $300,000 of program crops (Scenario VI).

Real ending net worth increased substantially (from 105% to 151%) for the 1443-acre farm for the policy alternatives involving current farm program payments; increases in real net worth occurred on the two larger farms under these policy alternatives, but at much lower rates of growth.

Policy alternatives involving farm program payments influence the growth in both acreage owned and leased on the 1443-acre farm; some growth in farm acreage occurred for this representative farm under the policy alternatives that eliminated or restricted farm program payments.

The 3119-acre farm and the 6184-acre farm experienced little or no growth in farm acreage under the policy alternatives that restrict or eliminated farm program payments.

The two largest farms reduced initial real estate debts substantially under all the policy alternatives considered; pay-back occurred under these policy alternatives for the 1443-acre farm but at rates considerably less than those for the two larger farms.

The 1443-acre farm generally paid back less of its initial real estate debt under the policy alternatives because expansion of farm size involved some purchase of additional cropland and purchase of additional machinery and equipment for expansion through leasing of cropland.

The two largest farms generally liquidated a smaller portion of intermediate-term debts than long-term debts under each of the policy alternatives.

The ratio of total equity to assets increased appreciably on each farm under each of the policy alternatives. This ratio increased by 27 to 33 percentage points from an initial level of 56% on the 1443-acre farm; it increased by 25 to 30 percentage points from an initial level of 60% on the 3119-

acre farm, and by 25 to 30 percentage points from an initial level of 64% on the 6184-acre farm.

Each of the representative farms are very dependent on farm program payments in maintaining reasonable levels of net farm income (i.e., returns to owned land, general farm overhead, and management and risk).

Stimulus to growth in real net worth and farm acreage is greatest for the 1443-acre farm under provisions of current farm policy and income tax regulations. The results indicate that moderate size farms are likely to expand to large size farms but little expansion is likely to occur on farms that are already large.

Failure to maintain effective program payment limitations or removal of payment limitations substantially increase net farm income on each representative farm; but such program provisions would be expected to result in relatively large government program payment outlays to farm producers represented by these three general crops farms.

Financial Bailout Strategies

Two farm credit policy alternatives were considered for assisting highly leveraged farmers remain solvent. The first was a debt restructuring policy whereby intermediate-term debt was refinanced and the repayment period was lengthened. To simulate the effects of such a credit policy, the financial position of the three representative general crops farms in the Delta Region of Mississippi were modified to depict highly leveraged farms. The long-term debt to asset ratio for each farm was increased to 55%, the intermediate-term debt to asset ratios were set equal to 60% (or 64% in the case of the 1443-acre farm), and annual interest rates on old loans were increased to their average values for 1980-1983 (11.37% for long-term and 13.4% for intermediate-term loans).

A second credit alternative was to provide the farm operators of the highly leverage farms with an interest rate reduction (subsidy) to offset the effects of high real interest rates. To compare the effects of these two financial bailout alternatives, the three representative farms were simulated under conditions of continuing the 1981 Farm Bill provisions but with the higher debt to asset ratios and the higher interest rates on long-term and intermediate-term loans (Scenario IX). Then the length of the intermediate-term loans was increased 1 year, to 7 years, and a portion of intermediate-term debt was converted to long-term debt provided the long-term debt to asset ratio did not exceed 65% (Scenario X). The annual interest rates, total debt loads and farm program provisions were the same as those used for the Base Finance Scenario (IX).

The second financial bailout alternative was simulated under the provisions of the Base Finance Scenario (IX), but with an interest subsidy provided during the first two years of the 10-year simulation period (Scenario XI). The interest subsidy was in the form of an interest rate reduction of 3.37 percentage points for long-term interest rates and 5.4 percentage points for intermediate-term interest rates. These interest rate reductions were the amounts necessary to reduce long-term interest (11.37%) and intermediate-term interest (13.4%) to a 4% real interest rate, assuming a 4% annual inflation rate.

The results from simulating the effects of these financial bailout alternatives on the highly leveraged farms are presented in Table 12. All three representative farms exhibited a 100% probability of survival and a 100% probability of having a positive after-tax net present value over the 10-year planning horizon for each of the scenarios. Average net present value for the farm operator and average present value of ending net worth were greatest under the debt restructuring alternative (Scenario X) for each of the representative farms.

Table 12. Comparison of selected financial bailout scenarios for the representative general crops farms in the Delta of Mississippi

Criteria	Alternative Scenarios[a] for 1443-acre farm			Alternative Scenarios[a] for 3119-acre Farm			Alternative Scenarios[a] for 6184-acre farm		
	IX	X	XI	IX	X	XI	IX	X	XI
Probability of survival (%)	100	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	100	100	100	100	100	100	100	100	100
After-tax net present value ($1,000)	1097.2	1178.5	1080.9	1918.4	2103.5	1656.5	2386.1	2955.0	2119.1
Average present value of ending net worth ($1,000)	1563.2	1655.7	1545.1	3237.2	3430.6	2967.7	5259.0	5839.7	4989.6
Average ending cropland owned (acres)	817.8	910.6	766.6	1870.2	2318.2	1627.0	3390.4	4244.8	3275.2
Average ending cropland leased (acres)	1290.8	1204.4	1258.8	1975.2	2400.8	2058.4	3216.0	3411.2	3177.6
Average ending cropland controlled (acres)	2108.6	2115.0	2025.4	3845.4	4719.0	3685.4	6606.4	7656.0	6452.8
Average ending long-term debts ($1,000)	648.1	840.7	520.5	1571.4	2449.9	1111.5	2484.4	4251.9	2047.4
Average ending intermediate-term debts ($1,000)	35.0	92.5	23.7	97.2	107.1	146.8	334.3	128.1	419.4
Average ending equity ratio (fraction)	0.73	0.68	0.77	0.69	0.61	0.74	0.69	0.61	0.71
Average internal rate of return (fraction)	0.12	0.12	0.11	0.10	0.11	0.09	0.07	0.08	0.06
Average annual net farm income ($1,000)	35.5	29.4	37.7	30.1	20.4	33.8	3.7	-14.8	5.4
Average annual government payment ($1,000)	48.4	48.4	48.3	49.9	49.9	49.9	49.9	49.9	49.9

[a] The scenarios are:
IX -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions for a highly leveraged farm.
X -- Restructure debt for a highly leveraged farm.
XI -- Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

Real wealth increased on each farm for the three alternative scenarios. The 1443-acre farm again exhibited the largest rates of growth in net worth (ranging from 135% for Scenario XI to 152% for Scenario X) as shown in Table 13. Each of the farms grew in acreage with the 1443-acre farm having the largest rates of growth and the 6184-acre farm exhibiting the slowest rates of growth. Long-term debts increased on each farm under Scenario X because farm growth came about through substantial cropland purchases. The 3119-acre farm and the 6184-acre farm had much smaller increases in cropland purchases (and in leased land) under the policy of an interest rate subsidy (Scenario XI). Consequently, the long-term debt on these two representative farms was reduced under Scenario XI. A substantial portion of the intermediate-term debt was repaid for each farm under Scenarios IX and XI as compared to Scenario X, because increased investment in machinery and equipment is required to operate the relatively larger farm under Scenario X. Only about half of the intermediate-term debt was paid back on each of the representative farms under the debt restructuring scenario. Consequently, the ratio of total equity to assets increased the least under this debt restructure policy alternative when compared with the Base Financial Scenario (IX) or the Interest Subsidy Scenario (XI).

Summary of Results from Financial Bailout Simulation

> All three farms had a 100% chance of remaining solvent and having a positive after-tax net present value over the 10-year planning horizon for each financial bailout alternative.
>
> Average net present value and present value of ending net worth increased substantially on each farm with the largest rate of growth in net worth occurring under the debt restructuring alternative (Scenario X).

Table 13. Rates of change in selected farm size, wealth and financial characteristics under alternative financial bailout scenarios for the representative general crops farms in the Delta of Mississippi

Criteria	Initial Situation	Percentage change in variable level from initial situation for alternative scenarios[a/] IX	X	XI
		1443-acre farm		
Present value of ending net worth ($1,000)	656.7	138	152	135
Cropland owned after 10 years (acres)	533.0	53	71	44
Cropland leased after 10 years (acres)	910.0	42	32	38
Total cropland controlled after 10 years (acres)	1443.0	46	47	40
Total long-term debts after 10 years ($1,000)	439.7(519.7)[b/]	47	62	18
Total intermediate-term debts after 10 years ($1,000)	227.3 (147.3)[b/]	-84	-37	-90
Total equity to asset ratio after 10 years (%) [c/]	49	73	68	77
		3119-acre farm		
Present value of ending net worth ($1,000)	1532.6	111	124	94
Cropland owned after 10 years (acres)	1419.0	32	63	15
Cropland leased after 10 years (acres)	1700.0	16	41	21
Total cropland controlled after 10 years ($1,000)	3119.0	23	51	18
Total long-term debts after 10 years ($1,000)	1170.7 (1383.5)[b/]	34	77	-5
Total intermediate-term debts after 10 years ($1,000)	472.0 (259.2)[b/]	-79	-59	-69
Total equity to asset ratio after 10 years (%) [c/]	48	69	61	74
		6184-acre farm		
Present value of ending net worth ($1,000)	3009.2	75	94	66
Cropland owned after 10 years (acres)	3064.0	11	39	7
Cropland leased after 10 years (acres)	3120.0	3	9	2
Total cropland controlled after 10 years (acres)	6184.0	7	24	4
Total long-term debts after 10 years ($1,000)	2527.8 (2987.4)[b/]	-2	42	-19
Total intermediate-term debts after 10 years ($1,000)	725.9 (266.3)[b/]	-54	-52	-42
Total equity to asset ratio after 10 years (%) [c/]	48	69	61	71

[a/] The scenarios are:
IX -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions for a highly leveraged farm.
X -- Restructure debt for a highly leveraged farm.
XI -- Interest rate subsidy (buy-down) in the first two years for a highly leveraged farm.

[b/] The initial situation was the same for the three financial bailout scenarios, except for the initial long-term and intermediate-term debts under Scenarios X which are given in the parentheses.

[c/] Values for all scenarios represent the percent equity in total assets after 10 years not the percentage changes in these equity to asset ratios.

Each representative farm expanded its acreage , both through cropland purchases and leasing of cropland, with the smallest farm (1443-acre farm) again exhibiting the most rapid rate of growth.

Long-term debt increased on each farm due to cropland purchases, with the exception of the two largest farms under an interest subsidy policy (Scenario XI).

Intermediate-term debt was reduced for each farm under each financial bailout scenario. The moderate size farm and the large farm reduced intermediate-term debt relatively more than the very large farm under these financial stress conditions.

The highly leveraged representative general crops farms in the Delta of Mississippi Region exhibit characteristics that indicate survival and growth under financial bailout policies. The implementation of the debt restructuring and interest subsidy policy alternatives would appear to stimulate substantial growth in farm acreage in this production region.

Impacts of No Technological Advance

Policy Scenarios I-XI were evaluated under the assumption of the most likely technology advance conditions whereby new technology would be introduced during the 1983-1992 period. Yield gains were projected as a result of "new technology" becoming available and being adopted on farms over the planning horizon based on the judgments of the OTA commodity panels.

The representative farms were simulated for three of the policy scenarios under the assumption that no new technology would become available for the crops over the 1983-1992 planning horizon. Mean crop yields for 1983-1992 were held constant at their historical 1974-1983 mean level. But since the simulations were stochastic, the actual yields were drawn randomly from the sample of yields for the 1974-1983 period. These yields were included for three farm commodity policy scenarios. Scenario XII assumes the Base Farm Policy Scenario (I) but with these lower mean yields; Scenario XIII assumes the "no target price or deficiency payment" situation (Scenario V) with the lower yields and Scenario XIV assumes the "no farm program" situation (Scenario VII), again with lower yields.

The results from the simulations are presented in Table 14. The no new technology scenarios had little effect on the probability of having a positive after-tax net present value on each farm. It reduced slightly the probability (to 96% to 98% for the 3119-acre farm and the 6184-acre farm, respectively) under the policy of No Farm Program (Scenario XIV). These probabilities of having a positive after-tax net present value did not change from the most likely technology situation on the 1443-acre farm. The impacts of these modest technology driven yield increases on product prices were not evaluated. Consequently, in the Base Farm Policy Scenario (XII), the moderate size and large size farms show small improvement in annual net farm income as a result of technological advance. The very large farm shows a substantial increase in net farm income since the technology adoption rate was much faster on this size of farm.

Table 15 provides a comparison of the rates of change from the initial situation in the farm acreage, wealth and farm financial variables assuming no change in technology and the most likely technology advance for the three policy alternatives. The present value of the farm operator's ending net worth increased at a slightly faster rate on each of the farms under the most likely technology scenarios than under the no new technology scenarios. The rate of increase was much higher for the Base Farm Policy scenarios (Scenarios I and XII), than for the other farm commodity policy scenarios for each of the farms.

Table 14. Comparison of selected farm policy alternatives assuming no new technology change for the representative general crops farms in the Delta of Mississippi

Criteria	Alternative Scenarios[a] for 1443-acre farm			Alternative Scenarios[a] for 3119-acre Farm			Alternative Scenarios[a] for 6184-acre farm		
	XII	XIII	XIV	XII	XIII	XIV	XII	XIII	XIV
Probability of survival (%)	100	100	100	100	100	100	100	100	100
Probability of a positive after-tax net present value (%)	100	100	98	100	100	96	100	100	98
After-tax net present value ($1,000)	1052.8	394.0	319.6	1066.0	640.0	514.5	1396.3	945.9	695.5
Average present value of ending net worth ($1,000)	1613.1	1103.5	1043.0	2785.7	2450.8	2354.4	5286.4	4915.2	4714.5
Average ending cropland owned (acres)	648.2	536.2	533.0	1428.6	1422.2	1419.0	3185.6	3144.0	3131.2
Average ending cropland leased (acres)	1358.0	1102.0	1054.0	1914.4	1725.6	1700.0	3136.0	3132.8	3129.6
Average ending cropland controlled (acres)	2006.0	1638.2	1587.0	3343.0	3147.8	3119.0	6321.6	6276.8	6260.8
Average ending long-term debts ($1,000)	215.7	124.2	181.1	136.4	204.9	303.4	286.5	293.6	415.4
Average ending intermediate-term debts ($1,000)	40.7	90.6	92.9	255.7	259.2	244.5	429.6	443.9	413.5
Average ending equity ratio (fraction)	0.88	0.86	0.83	0.89	0.87	0.84	0.89	0.89	0.88
Average internal rate of return (fraction)	0.11	0.06	0.05	0.06	0.04	0.04	0.04	0.04	0.03
Average annual net farm income ($1,000)	38.6	-7.3	-18.3	34.0	-11.9	-29.9	15.1	-27.5	-57.7
Average annual government payments ($1,000)	48.2	1.9	0.0	49.9	4.8	0.0	49.9	7.9	0.0

[a] The scenarios are:
XII -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions, assuming no new technology scenario.
XIII -- No Target Price/Deficiency Payment program in 1983-1992, assuming no new technology scenario.
XIV -- No Farm Program in 1983-1992, assuming no new technology scenario.

Table 15. Rates of change in selected farm size, wealth and financial characteristics under selected farm policy and technological advance alternatives for the representative general crops farms in the Delta of Mississippi

Criteria	Initial Situation	Percentage change in variable level from initial situation for alternative scenarios[a]: Assuming most likely technology			Assuming no new technology		
		I	V	VII	XII	XIII	XIV
		1443-acre farm					
Present value of ending net worth ($1,000)	748.6	120	51	43	115	47	39
Cropland owned after 10 years (acres)	533.0	22	1	0	22	< 1	0
Cropland leased after 10 years (acres)	910.0	49	21	16	49	21	16
Total cropland controlled after ten years (acres)	1443.0	39	14	10	39	14	10
Total long-term debts after 10 years ($1,000)	331.4	-34	-63	-48	-34	-62	-45
Total intermediate-term debts after 10 years ($1,000)	243.8	-84	-63	-63	-83	-63	-62
Total equity to asset ratio after 10 years (%) [b]	56.0	88	87	84	88	86	83
		3119-acre farm					
Present value of ending net worth ($1,000)	1921.5	53	32	28	45	28	23
Cropland owned after 10 years (acres)	1419.0	1	< 1	0	< 1	< 1	0
Cropland leased after 10 years (acres)	1700.0	11	< 1	0	13	2	0
Total cropland controlled after 10 years (acres)	3119.0	7	< 1	0	7	< 1	0
Total long-term debts after 10 years ($1,000)	840.8	-84	-81	-74	-84	-76	-64
Total intermediate-term debts after 10 years ($1,000)	413.0	-38	-33	-40	-38	-37	-41
Total equity to asset ratio after 10 years (%) [b]	60.0	89	87	87	89	87	84
		6184-acre farm					
Present value of ending net worth ($1,000)	4047.5	35	28	25	31	21	16
Cropland owned after 10 years (acres)	3064.0	2	1	1	4	3	2
Cropland leased after 10 years (acres)	3120.0	< 1	< 1	1	< 1	< 1	< 1
Total cropland controlled after 10 years (acres)	6184.0	1	< 1	1	2	2	1
Total long-term debts after 10 years ($1,000)	1640.8	-93	-92	-86	-83	-82	-75
Total intermediate-term debts after 10 years ($1,000)	574.7	-21	-19	-29	-25	-23	-28
Total equity to asset ratio after 10 years (%) [b]	64.0	91	91	90	89	89	88

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[a] The scenarios are:

I -- Continuation of the 1981 Farm Bill and 1983 federal tax provision, with most likely technology advance scenario.
V -- No Target Price/Deficiency Payment in 1983-1992, with most likely technology advance scenario.
VII -- No Farm Program in 1983-1992, with most likely technology advance scenario.
XII -- Continuation of the 1981 Farm Bill and 1983 federal tax provision with no new technology scenario.
XIII -- No Target Price/Deficiency Payment in 1983-1992, with no new technology scenario.
XIV -- No Farm Program in 1983-1992, with no new technology scenario.

[b] Values for all scenarios represent the percent equity in total assets after 10 years not the percentage change in these equity to asset ratios.

The results in Table 15 show that the rates of growth in cropland purchases, leasing and total farm acreage were almost identical under the two technology situations for a given representative farm. However, the 1443-acre farm exhibited substantially higher growth rates in farm acreage than the two larger farms. Also, the rates of payback on long-term and intermediate-term loans under the two technology situations were near identical for a given representative farm.

These results indicate that the most likely technology changes projected for the Delta of Mississippi Region are expected to have the greatest impact on growth in real wealth and farm acreage of the 1443-acre farm. The 3119-acre farm and the 6184-acre farm are expected to exhibit little growth in farm acreage over the 10-year simulation period. The economic impact expected from new technology is rather minimal compared with the economic impact from changing the farm commodity price and income support programs.

New Entrant into Farming

The above simulation results for the alternative farm commodity policies assumed the representative farms were operated by established farm operators. These simulations provide indications of the impacts of the alternative farm policies in the relative short-run. They do not provide information on the survivability and economic viability of potentially new entrants into farming. To obtain some indication of the longer-run effects of selected farm policies, the 1443-acre general crops farm was analyzed for three farm policy scenarios (I, V and VII) assuming the most likely technology advance scenarios and that the farm operator was a new entrant in farming.

The entering farm operator was assumed to have minimum equity in farmland (30%) and farm machinery (35%) and all farm machinery was considered to have a 1982 new machinery cost. Annual interest rates for current long-term loans and intermediate-term loans were set equal to the average interest rates for 1980-1983 (11.37% and 13.4%, respectively). The farm operator was assumed to be purchasing 533 acres of cropland and leasing 910 acres for a total of 1443 acres.

The results from the simulations for a new entrant under the three policy scenarios are provided in Table 16. Under the Base Policy Scenario XV (continuation of the 1981 Farm Bill), the new entrant had a 100% chance of remaining solvent for 10 years, and the operator had a 100% probability of having a positive after-tax net present value. Net worth increased by 98% over the 10-year period, and the farm grew by 27% in total cropland acreage controlled after 10 years. Much of the growth in farm acreage resulted from leasing additional cropland (31% increase) with some increase in purchased acreage (19%). Long-term debt increased 42%, while almost all of the intermediate-term debt (91%) was paid back. The total equity to asset ratio increased from the initial situation of 33% to 61% after the 10 years.

When the Target Price/Deficiency Payment Program (Scenario XVI) or the No Farm Program (Scenario XVII) alternatives were considered the probability of the farm operator remaining solvent dropped to 76% and 62%, respectively. The mean value for after-tax net present value was negative for the no farm program option. Owned cropland acreage decreased 53% under Scenario XVI and 51% under Scenario XVII as the new entrant was forced to sell off cropland in an attempt to remain solvent. Long-term debts were reduced by around 40% from their initial levels,

Table 16. Comparison of selected farm policy alternatives for a new entrant on the representative 1443-acre general crops farm in the Delta of Mississippi

Criteria	Initial Situation	Alternative Scenarios[a/]			Percentage change from initial situation[a/]		
		XV	XVI	XVII	XV	XVI	XVII
Probability of survival (%)	--	100	76	62	--	--	--
Probability of a positive after-tax net present value (%)	--	100	70	58	--	--	--
After-tax net present value ($1,000)	--	629.8	57.2	-35.7	--	--	--
Present value of ending net worth ($1,000)	498.3	984.9	395.4	319.0	98	-21	-36
Cropland owned after 10 years (acres)	533.0	636.4	249.2	260.4	19	-53	-51
Cropland leased after 10 years (acres)	910.0	1193.8	1209.8	1182.6	31	33	30
Total cropland controlled after 10 years (acres)	1443.0	1830.2	1459.0	1443.0	27	1	0
Total long-term debts after 10 years ($1,000)	519.7	737.3	299.9	306.3	42	-42	-41
Total intermediate-term debts after 10 years ($1,000)	471.7	41.0	200.6	248.4	-91	-57	-47
Total equity to assets after 10 years (fraction)	0.33	0.61	0.51	0.47	--	--	--
Internal rate of return after 10 years (fraction)	--	0.11	0.00	-0.07	--	--	--
Average annual net farm income ($1,000)	--	-18.8	-76.8	-91.3	--	--	--
Average annual government payments ($1,000)	--	47.3	2.3	0.0	--	--	--

[a/] The scenarios are:
XV -- Continuation of the 1981 Farm Bill and 1983 federal tax provisions .
XVI -- No Target Price/Deficiency Payment Program for 1983-1992 .
XVII -- No Farm Program in 1983-1992 .

while about half of the intermediate-term loans were repaid. The farm remained in operation on average of 9 years under Scenario XVI, and an average of 8 years under the No Farm Program Scenario (XVII).

Because the entering farm operator started with minimum equity in land and new farm machinery, full costs of using these resources were incurred. The relative low probabilities of survival for Scenarios XVI and XVII indicate the dependency of new entrants on an income and price support program. These results indicate that as long as resources remain overvalued in Delta of Mississippi agriculture, the industry will continue to depreciate out current investment and few new operators will enter farming in the absence of farm commodity price and income support programs. As a practical matter, a new entrant into the region's agriculture with low equity can probably only survive by using mainly one or more of the following strategies: 1) leasing land and/or machinery, 2) achieving much higher than average crop yields, and 3) arranging financing that postpones a part of the initial liability for principal and/or interest payments. The net farm incomes for Scenarios XVI and XVII are negative in large amounts (Table 16). Thus, even the successful implementation of these strategies is not likely to ensure successful establishment of this new entrant in farming for extended periods of time.

Summary of Results From All Simulations

Some of the major findings from the simulation analysis are summarized below.

Farm Commodity Program Alternatives

All three represent farms in the Delta of Mississippi Region have a 100% probability of survival over the 10-year period (1983-1992) under the entire range of farm program (and no program) alternatives that were considered. Further, the probability of the farm operator having a positive after-tax net present value is at or near 100% under the range of farm programs considered. However, in the absence of some or all of the provisions in the current farm commodity program, each of the representative farms experienced negative annual net farm incomes. Even though they remained solvent over the 10-year planning horizon, these negative net farm incomes portend financial difficulties on each farm over extended periods of time.

Targeting of farm program benefits to farms that produce $300,000 or less in program crops has dramatic economic impact even on the moderate size (1443-acre)farm. As a general rule, the very large farm fares the best with the loss of all farm programs because it operates with substantial acreage of leased land, has much less economic incentive to grow in acreage size than the moderate or large farms, and uses more of the retained farm earnings and off-farm income to retire long-term land and intermediate-term machinery debts. The greatest economic incentives to grow in acreage size ocurred on the moderate size (1443-acre) farm for all farm commodity program options considered.

In general, it appears that the two largest farms had captured most of the economies-to-size available to them, and only the moderate size farm faced potentials for substantial growth irrespective of the farm commodity policy followed. Continuation of current farm policy but without program payments limitations would provide for the greatest growth of this moderate size farm, with the two largest farms exhibiting only moderate increases in farm acreage.

Income Tax Provisions

The reduction in income tax benefits had its major adverse economic impacts for the very large (6184-acre) farm through a reduction in net farm income of $36,000 annually compared to the Base Farm Policy Scenario (I). The moderate size (1443-acre) farm and the large size (3119-acre) farm also experience annual net farm income reductions of $9,000 and $16,500, respectively. The farm operator's average present value of ending net worth on the moderate size farm under the restrictive income tax provisions was 7% (or some $188,000) less than for the Base Farm Policy Scenario. In contrast, the large and very large farms experienced an increase in ending net worth of some 7% and 8%, respectively, under the restrictive income tax provisions as compared with the Base Farm Policy Scenario.

Each of the three farms failed to grow as rapidly in total farm acreage under the restrictive income tax provisions as under the Base Farm Policy Scenario, with the greatest impact occurring for the moderate size and large size farm. Although, a more restrictive income tax policy would adversely affect each of the three farms in the Delta of Mississippi Region, the impact is rather modest compared to the loss of economic benefits from withdrawing the price or income support payment programs or the entire complement of existing farm commodity programs.

Increased Debt Load and Financial Bailout

Increasing debt loads to a level of 60% (or 64% for the moderate size farm) of machinery value and 55% of land value resulted in the heaviest economic drag on the very large farm whereby average annual net farm income drops to $3,700. This adverse economic impact results mainly from the much higher land and machinery interest payments as the debt to asset ratios are increased from 36% to 55% for land and 48% to 60% for machinery. Because of this heavy debt load the very large farm continues to exhibit low (or negative) average annual net farm income with either a debt restructuring or an interest rate subsidy type of financial bailout.

The interest rate subsidy was the most beneficial of the two alternatives with respect to annual net farm income, particularly for the moderate size and large size farms. However, the debt restructuring alternative provided the greatest incentive for additional growth in total acreage, particularly for the these two smaller size farms that were in a position to increase their purchases of cropland. In general, the three representative farms under the higher debt loads would be able to survive and grow in total farm acreage over the 10-year planning period without either of the financial bailout alternatives that were used in the simulations.

No New Technology

The alternative of having "no new technologies" developed and available for adoption was simulated by holding mean crop yields constant at their 1983 levels, and assuming the distribution of yield on a year-to-year basis experienced during 1974-1983. Since the yield increases under the "most likely technology" scenarios do have a favorable benefit/cost ratio, the "no new technology" scenarios have the effect of reducing annual net farm incomes on each representative farm. These reductions were a modest $300 and $4,300 annually on the moderate size and large size farms, respectively. However, for the very large farm with a much shorter time lag in adopting new yield enhancing technology the impact was to reduce annual net farm income by $26,800.

These benefits from new technology were rather modest when compared to the benefits from farm commodity price and income support programs. Moreover, the benefits from new technology could largely disappear for even the very large farms should the expected yield increases expand total output in relation to demand sufficiently to reduce cotton and grain prices.

New Entrants Into Farming

High land and machinery costs faced by a new entrant on the moderate size farm adversely impact on the average annual net farm income. Even though the probability of survival over the 10-year period is 100% under the Base Farm Policy (Scenario I), annual net farm income is a negative $18,800, which portends for financial difficulty over a longer period of time. This probability of survival drops to 76% when the target price/deficiency payment provisions are withdrawn and to 62% with the loss of all farm commodity programs. Thus the economic survival of new entrants into farming is particularly dependent on price and income benefits from farm commodity programs (or of some other type of financial assistance). In the absence of such programs, few new farm operators entering farming in the Delta of Mississippi Region would be expected to experience economic success over the next ten years.

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Background Paper No. 7

Economic, Policy, and Technology Factors Affecting Herd Size and Regional Location of U.S. Milk Production

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INTRODUCTION

During the 1970's, milk production increased 41 percent in the Southwest region of the United States and 33 percent in the Northwest while total U.S. milk production increased only 11 percent (figure 1). Much of the expansion has been on dairies with more than 500 cows, with 1500 to 2000-cow herds being common. Although 303,710 farms in the U.S. reported having milk cows in 1983, less than 5,000 well managed dairies with 1500-cows each could have produced all the milk sold commerically that year.

This report examines important economic factors that will effect the trend to fewer and larger dairies and the regional shift in milk production.

The first part of the study estimates the relative long-term profitability of milk production for medium, large and extra large dairy operations in five major U.S. dairy areas. These comparisons provide an indication of the most competitive farm sizes and regions. They are based on returns to investment after all costs are paid including the required replacement of depreciable assets needed to maintain the long-term productive capacity and viability of the farm.

The second part of the study develops a beginning financial situation for eight dairy operations in three regions. Their ability to remain solvent and increase net worth over a ten-year planning horizon is simulated under conditions of risk and under alternative policy and technology scenarios. These results provide an indication of how alternative policies effect individual dairy farm operations. The impact of alternative policies on high debt and new entrant dairies is also examined.

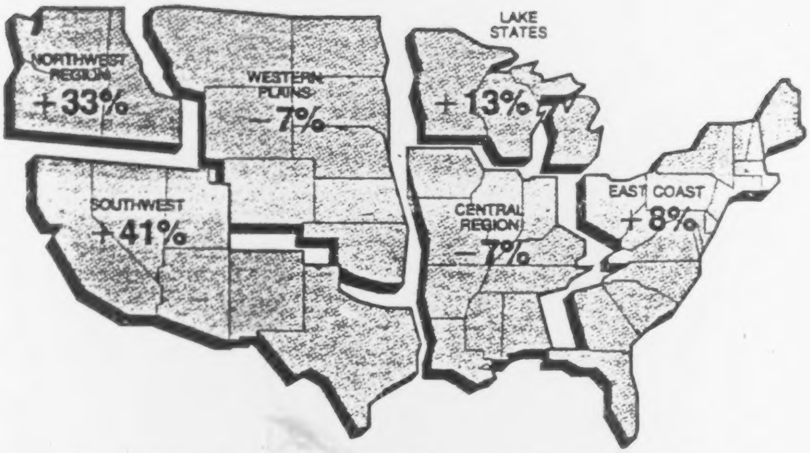
NORTHWEST REGION
+33%
WESTERN PLAINS
-7%
LAKE STATES
+13%
SOUTHWEST
+41%
CENTRAL REGION
-7%
EAST COAST
+8%

Figure 1. **How the Dairying Picture Has Changed**

(Percent change in milk production in various regions from 1970–71 to 1980–81).

METHODOLOGY

A three step procedure was employed in this study. The first was to use federal milk marketing order data to identify medium, large and extra-large dairy operations in each of five major dairy areas. State of the arts technologies and practices used on these well managed dairies were then identified from secondary sources and visits with dairy producers, university and government employees and building and equipment representatives.

The second step was to develop investment (replacement) cost requirements for new dairy operations of the selected sizes using an economic-engineering procedure. Based on this information and information from secondary sources, long-term average annual cost and return budgets were prepared and an expected rate of return to investment in milk production calculated.

The third step was to obtain information on long- and intermediate-term debts, net worth and equity to asset positions of dairy farms using the U.S. Department of Agricultures' 1979 Agricultural Finance Survey. The financial chracteristics were combined with the whole farm budgets developed in step-two to provide a beginning 1983 situation for selected size dairies in three regions. Then the FLIPSIM V model at Texas A&M University was used to simulate the economic viability and performance of each dairy under selected policy and technology scenarios.

LONG-TERM PROFITABILITY

Dairy Operations Considered

Herd size, technologies employed and practices used in milk production vary considerably across the United States. In May 1983 the average herd size for 120,655 producers selling milk to plants regulated by federal milk marketing orders was 63 cows per farm (Table 1).[1] However, the average herd size varied from 49 cows in Pennsylvania to 532 cows in Florida.

The variation in herd size within each state was even more dramatic. Although the average herd size in Florida was 532 cows, the average herd size for the largest ten percent of the herds in that state was 1,861 cows (Table 1). For the largest ten percent the average herd size varied from about 1,800 cows in Florida and 1,700 cows in the Southwest to about 125 cows in the Lake States region. Generally dairy herds are much larger in the Southwest, Southeast, and Northwest regions than in the Lake States and Northeast regions.

From the herd size information in Table 1, twenty-two dairies were selected to represent existing herd sizes in five major dairy areas (Table 2). The 200-cow Pennsylvania and 600-cow New York dairies exceed the average size of the largest ten percent of dairies in those

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[1] Buxton, Boyd M. and John P. Rourke. Size Distribution of Dairy Farms Marketing Milk Under Federal Milk Orders. Unpublished report. Economic Research Service, U.S. Department of Agriculture. April 1984. Note - the 120,655 farms accounted for about 69 percent of all milk produced in May 1983, but excluded most farms in California and other states where there is no federal milk order.

Table 1. Total producers and size distribution of herds selling milk to plants regulated by federal milk marketing orders, May 1983.

	Average Herd Size for					
Region (State)	Total Producers	All Farms	Largest Ten Percent	89-70 Percentile	69-40 Percentile	Smallest forty Percent
	number	milk cows				
Lake States						
Minnesota	9,968	53	116	74	49	30
Wisconsin	24,400	54	133	68	52	28
Northeast						
Pennsylvania	12,928	49	127	66	44	25
New York	13,374	59	162	81	53	27
Southeast						
Georgia	962	127	343	181	117	54
Florida	352	532	1,861	931	355	133
Southwest						
New Mexico	176	333	1,832	433	169	32
Arizona	160	510	1,733	714	433	160
California	13	400	1,640	580	253	110
Northwest						
Idaho	574	135	607	169	90	34
Washington	1,647	127	418	171	108	46
United States	120,655	63	202	82	54	26

Table 2. Representative dairies selected for preparation of whole farm budgets, by region and herd size.

Region/State	Herd Size	Crop-land	Housing Facilities[a]	Sun Shades	Feed Produced	Silage Storage	Total Labor
	(cows)	(acres)	(type)			(type)	(W/e)[b]
Lake States							
Minnesota	52	188	Stanchion	No	Most	Upright	2.03
Minnesota	125	449	Free Stall	No	Most	Upright	3.30
Northeast							
Pennsylvania	52	156	Stanchion	No	Forage	Trench	2.2
Pennsylvania	125	375	Free Stall	No	Forage	Trench	3.8
Pennsylvania	200	600	Free Stall	No	Forage	Trench	5.54
New York	52	156	Stanchion	No	Forage	Trench	2.21
New York	200	600	Free Stall	No	Forage	Trench	5.54
New York	600	1800	Free Stall	No	Forage	Trench	14.36
Southeast							
Georgia	200	400	Free Stall	Yes	Forage	Trench	4.5
Georgia	350	700	Free Stall	Yes	Forage	Trench	7.84
Florida	350	0	Open Field	Yes	None	NA	7
Florida	600	0	Open Field	Yes	None	NA	11
Florida	1436	0	Open Field	Yes	None	NA	18
Southwest							
New Mexico	900	0	Corrall	Yes	None	NA	13
Arizona	359	0	Corrall	Yes	None	NA	7
Arizona	834	0	Corrall	Yes	None	NA	12
Arizona	1436	0	Corrall	Yes	None	NA	16
California	550	0	Corrall	Yes	None	NA	9
California	1436	0	Corrall	Yes	None	NA	16
Northwest							
Washington	140	51	Free Stall	No	Silage	Trench	2.96
Idaho	200	400	Corrall	No	Most	Trench	5.0
Idaho	550	0	Corrall	No	None	NA	10.5

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[a] Housing types are:

Stanchion - A conventional barn with locking stanchions in which cows are milked and fed.

Free Stall - A covered barn with individual stalls in which cows can free enter and exit.

Open Field - A field where cows are kept that is large enough to maintain plant cover.

Corral - A drylot open pen where cows are kept and fed at a fenceline feeder.

[b] Labor in worker equivalents of 2,500 hours annually.

NA = not applicable.

states. However, these larger sized dairies exits in these States and likely will become more prevalent in the future.[2/]

Technologies and Practices

The technologies and practices assumed for each of the 22 dairy operations were based on discussions with dairy producers, university and government employees and equipment representatives. The objective of these discussions was to describe an "efficiently" organized dairy operation using proven technologies and practices for each specified herd size. Therefore, the dairy operations in this study are not average of what now exists but rather approximate modern sizes and types of operations.

The 52-cow dairies in Minnesota, Pennsylvania, and New York use the conventional stanchion barns for housing and milking cows (Table 2). For larger herds in the Lakes States, Northeast, Washington, and Georgia, free stall housing and milking parlors are assumed.

Cows are kept in open corrals throughout the Southwest and on larger Idaho dairies. Sun shades in the corrals are assumed in New Mexico, Arizona, and California (Southwest) but not in Idaho. Cows are milked twice a day in milking parlors and fed at fenceline bunks from a feed wagon or truck.

Open fields with sun shades are assumed in Florida. One-half acre per cow is provided allowing fields to remain plant covered in

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[2/] Based on discussions with Bill Grizzly at Penn State University and Robert Milligan and Wayne Knoblauch at Cornell University. However, the author takes responsibility for actual development of budgets for these size dairies.

order to minimize mud problems. Cows are milked twice a day in a milking parlor. After leaving the milking parlor, cows are fed concentrates in a feed barn before being released back to the field. Roughage is fed loose in the open fields.

The source of feed follows the common practice existing in the various states. Most feed is purchased from off the dairy operation in New Mexico, Arizona, California, and Florida. The same is assumed for the 550-cow Idaho dairy. Dairy operations in Pennsylvania, New York, and Georgia, purchases most of the concentrates but produce most of the forage used by the dairy herd. All feed is assumed to be produced on the Minnesota and the 200-cow Idaho dairies. A relatively small quantity of silage is raised on the Washington dairy which purchases all concentrates and alfalfa hay from off the farm.

Except for Minnesota, silage produced on the dairy operation is stored in trench silos. In Minnesota vertical upright concrete-stave silos are assumed for storaging silage, haylage and high moisture corn.

Profitabifity Measure

A simple average annual rate of return to total investment is used to measure profitability and to compare returns on the twenty-two dairy operations. The measure is:

$$r = \frac{R - OC - OS}{I}$$

where: r = the average annual rate of return,

R = total annual revenue from all sales, including milk, dairy replacements, cull cows, and bull calves,

OC = total annual operating costs for the entire dairy, including wages of hired labor and an allowance for the owner-operator's labor and management,

OS = total annual ownership costs including depreciation but excluding interest costs, and

I = total investment outlay for the entire dairy operation.

The measure of profitability is pre-income tax. Therefore, no explicit consideration is given to possible investment incentives created for specific individuals through tax regulations, such as expensing, rapid depreciation and investment credits. This limits the conclusions of the study but avoids the need for assumptions about each investor's own financial situation. For example, a tax liability may be calculated strictly on the income from the dairy operation itself or including nondairy income or business(es) for which the dairy would be just a part of a much bigger tax liability picture.

The debt/asset ratio, liquidity, and solvency measures vary for each person who might set up one of the dairies. Although these measures affect an individual's success and long-term viability in milk production, they are ignored here. Over time, dairy owners supported by adequate financial backing and favorable net worths would be attracted if the rate of return on total investment (profitability) was high enough.

In the long-term, the profit opportunities in dairy will affect milk production more than net worth, liquidity, or solvency positions of specific individuals. Some of these questions are considered in a later part of this report.

The calculations for total revenue above all costs and costs per hundredweight (cwt) of milk cover payments for all factors, including the owner labor and management and a real interest charge on the average annual investment. The cost per cwt of milk was adjusted because sales, though dairy-related, include more than milk.

Annual Costs

Annual costs reflect the assumptions used to calculate depreciation, property taxes, insurance, and interest costs. The following calculations are used in this study:

Depreciation

$$\text{Annual Depreciation} = \frac{PC - (SV)\ (PC)}{UL}$$

where:

PC = purchase cost,

SV = salvage value expressed as a proportion of purchase cost, and

UL = useful life in years.

Property tax--Annual property taxes for depreciable assets are calculated as a proportion of the assets' average annual value over its useful life. The average annual value over its useful life. The average annual value is calculated as:

$$AAV = \frac{PC + (SV)\ (PC) + \frac{(PC + (SV)\ (PC))}{UL}}{2}$$

where:

PC, SV, and UL are as described before.

The dollars of tax per $100 of average annual value reflects property tax by using percentages of market value.

Insurance--Insurance costs for depreciable assets are based on a rate per $100 of annual average value. Annual average value is calculated the same as in the property tax computation.

Insurance costs include coverage on one-half the value of hay inventory but no coverage on livestock, silage, or concentrates.

Interest--Interest costs for depreciable assets are based on the real interest rate multiplied by the annual average value.

Costs and Returns

The specialized dairy operations considered in this report receive all revenue from the dairy enterprise. Milk sales are the single largest source of revenue, but the sale of cull cows, bull calves, and replacement heifers beyond those needed for herd replacement are also important. Price changes for any of these items would greatly affect total revenue generated by the dairy operation and, therefore, the rate of return to total investment.

Revenue

Revenue from milk sales depends on milk produced and the price received for milk sold. Prices received for milk delivered to plants vary from one state to another, largely reflecting the classified pricing policy of federal and state milk orders and the proportion of milk used as fluid in the various states.

The level of milk production per cow used is the same as the average achieved by herds in the 1982 Dairy Herd Improvement Association (DHIA) program in the respective states.

Costs

The average annual cost is divided into operating and ownership costs. Operating costs include purchased feed and a wide range of expenses such as farm repairs, hired and operator labor, utilities and fuel for the dairy herd, and veterinary and breeding fees. Operating costs also include seed, fertilizer, fuel, and other annual expenses associated with feed production on Minnesota and Washington dairies.

Annual ownership costs include depreciation, property taxes and insurance premiums. Annual depreciation was calculated for durable assets including buildings and dairy equipment, tractors, vehicles, and field equipment. Property taxes and insurance premiums were based on annual dollars paid per $100 of average annual value.

All interest charges, except interest on operating costs, were excluded to calculate the average annual rate of return to total investment.

Labor is paid before calculating the rate of return to total investment. If the calculated rate of return (r) is greater than the interest rate, then retained earnings are positive.

Feed Requirements--Feed is the most important cost of producing milk, whether purchased outright or raised on the dairy farm. Differences in feed assumptions can make a significant difference in the relative rate of return to investment in the various states. The ration composition differs from state to state. However, it was assumed that a milk cow of a given weight and breed and producing the same amount of milk would require the same dry matter intake, regardless of location. Variations in regional forage quality can be partly offset by changing the composition of the concentrates and by adding supplements so as to yield a balanaced ration. To the extent it cannot, milk production per cow would be lower.

Data show the average annual pounds of dry matter intake per day per 100 pounds of body weight to be 2.326 plus 0.004824 multiplied by the hundred weights of milk produced by the cow per year.[3/] Feed fed by state and milk per cow are shown in Table 3.

The proportion of dry matter from concentrates in the various states was estimated from the pounds of grain fed to a milk cow as reported by the U.S. Department of Agriculture's Statistical Reporting Service.[4/] It was assumed that forages constituted the remaining dry matter requirement.

Producers are assumed to feed 11,877 pounds of hay, 627 pounds of grain, 52 pounds of calf starter, and 40 pounds of milk replacer to a dairy heifer replacement to reach 1,250 pounds body weight in 26 months. A dairy bull that weighs 2,000 pounds is assumed to require 4,056 pounds of grain and 7,300 pounds of hay per year.

[3/] Data are from Minnesota Dairy Herd Improvement Association summaries

[4/] U.S. Department of Agriculture, Milk Production, Statistical Reporting Service, July 16, 1982, p. 6.

Table 3. Annual feed requirements for adult milk cows and annual milk production per cow.

State	Annual Feed Fed[a]				Annual Milk/Cow
	Hay	Silage	Haylage	Concentrate	
	pounds				
Minnesota	3,639	9,703	7,116	4,816	14,764
Pennsylvania	5,301	7,068	5,183	5,200	15,260
New York	5,820	7,761	5,691	4,350	15,540
Washington	8,171	5,447	0	5,930	16,954
Idaho	10,375	0	0	5,180	15,170
Georgia	4,235	12,848	0	6,080	13,149
Florida	4,235	0	0	10,320	13,149
New Mexico	9,244	0	0	6,410	16,135
Arizona	8,733	0	0	6,970	16,570
California	8,871	0	0	6,800	16,371

[a] Weights are as fed. Dry matter content of feed varies some by state but is approximately 89 percent for alfalfa, 33 percent for silage, 45 percent for haylage and 90 percent for concentrate.

Total hired labor ranges from 1.03 worker equivalents (2,575 hours) of part-time hourly labor on the 52-cow Minnesota dairy to 18 full-time workers on the 1,436-cow Florida dairy. Some of the part-time labor hired in Minnesota, Pennsylvania, New York and Washington is seasonal and associated with crop production (Table 2).

Investment Requirements

The estimated new (replacement) cost per cow for assets required on the twenty-two dairies are summarized in Table 4. Replacement or new costs are used so that the average annual costs of ownership will reflect an amount sufficient to replace worn out assets when needed. Costs then reflect an amount needed to maintain the long-term viability of the operation.

On dairies without cropland for feed production, the total investment per cow ranges from $3,372 on the 1,436-cow Florida dairy to $5,053 for the 359-cow Arizona dairy. Including land and field machinery to produce feed, a Minnesota 52-cow dairy has a total replacement value of assets of more than $15,000 per cow. The difference between herd sizes and regions are best reflected in comparing investment per cow in dairy buildings and equipment. Here the range is from $749 on the 1,436-cow Florida dairy to $4,871 for the 52-cow Minnesota dairy (Figure 2). The investment per cow in dairy buildings and equipment is substantially less on larger than on smaller dairies regardless of region. For typical herd sizes, the investment per cow is substantially less in Southeast and Southwest regions than in other regions. However, the 600-cow New York and 550-cow Idaho dairy

Table 4. Summary of replacment investment cost per cow for dairy operation.

Region/State	Herd Size	Dairy Builing and Equip.	Tractor and Vehicles	Field Machinery	Cattle	Land	Milk Base	Total	Total Farm ($1000)
	number	- - - - - - - - - - - - - - -	- - - - - - - - - -	dollars	- - - - - - - - - -	- - - - - - - - - -	- - - - - - - - - -	- - - - - - - - - -	
Lake States									
Minnesota	52	4,871	1,764	1,503	1,800	5,517	0	15,455	804
Minnesota	125	4,172	1,015	575	1,800	5,481	0	13,043	1,630
Northeast									
Pennsylvania	52	4,094	1,771	1,488	1,800	4,595	0	13,749	715
Pennsylvania	125	3,683	833	640	1,800	4,555	0	11,511	1,439
Pennsylvania	200	2,770	753	400	1,800	4,536	0	10,259	2,052
New York	52	4,094	1,771	1,445	1,800	4,673	0	13,784	717
New York	200	2,748	749	389	1,800	4,613	0	10,299	2,060
New York	600	1,506	338	192	1,800	4,600	0	8,436	5,062
Southeast									
Georgia	200	2,262	539	278	1,800	3,113	0	7,990	1,598
Georgia	350	1,667	308	159	1,810	3,086	0	7,029	2,460
Florida	350	1,240	168	20	1,811	750	0	3,989	1,396
Florida	600	1,026	141	16	1,810	750	0	3,744	2,246
Florida	1,436	749	59	7	1,807	750	0	3,372	4,842
Southwest									
New Mexico	900	1,353	63	0	1,810	261	0	3,487	3,138
Arizona	359	1,789	125	0	1,811	110	1,218	5,053	1,814
Arizona	834	1,414	68	0	1,811	109	1,218	4,620	3,853
Arizona	1,436	1,161	50	0	1,811	107	1,218	4,346	6,241
California	550	1,797	81	0	1,810	291	805	4,784	2,631
California	1,436	1,385	50	0	1,810	217	805	4,267	6,127
Northwest									
Washington	140	2,504	519	363	1,800	1,714	88	6,989	978
Idaho	200	2,337	444	474	1,800	3,113	0	8,168	1,634
Idaho	550	1,474	111	0	1,810	109	0	3,504	1,927

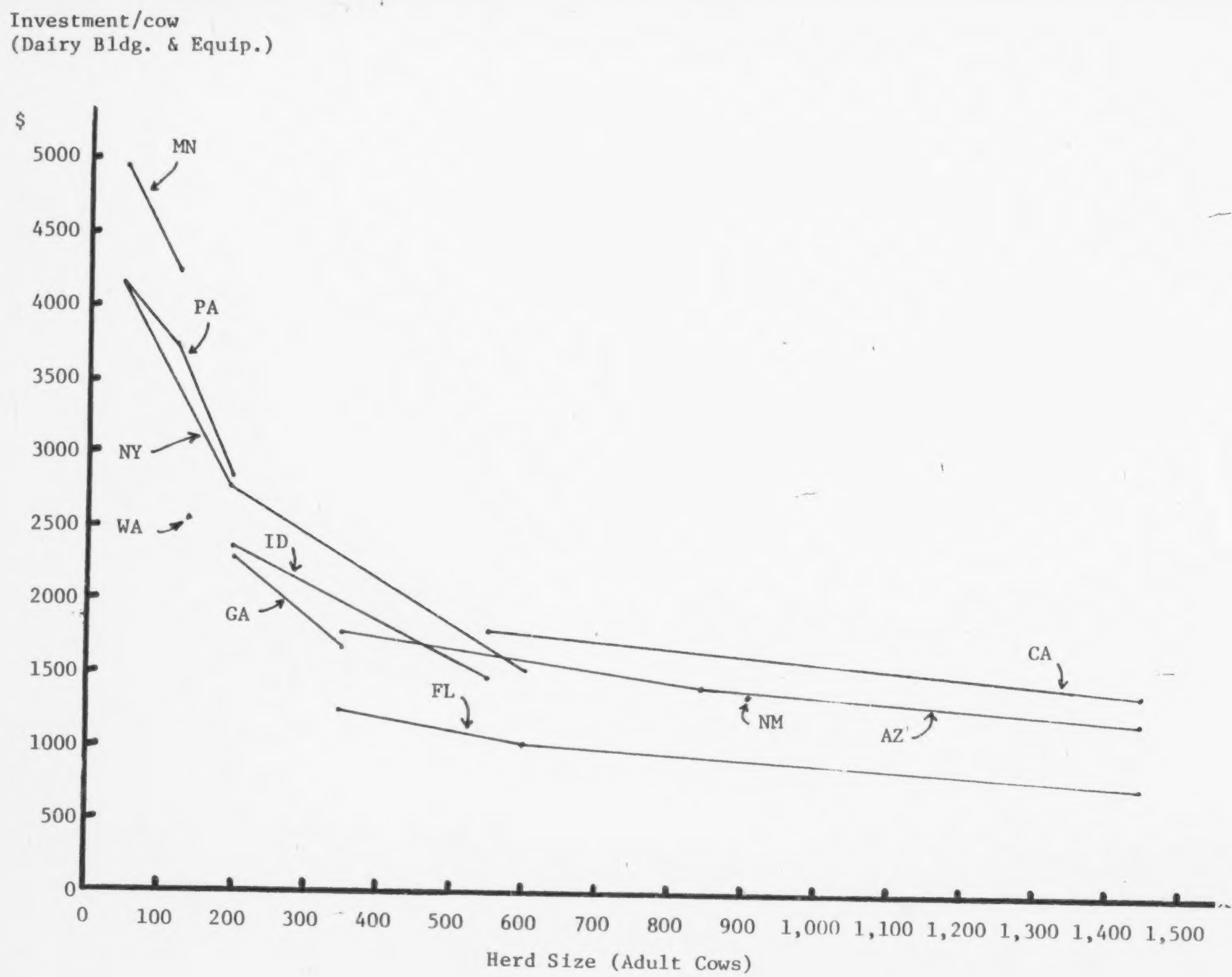

Figure 2. Replacement investment per cow in dairy building and equipment by herd size and state.

have investment requirements for dairy buildings and equipment quite comparable to large dairies in other regions.

Policy Scenarios

The base scenario assumes the "all" milk prices received by dairy producers in 1982 (Table 5). The price varies from $12.70 cents per cwt in Idaho to $16.40 in Florida. The difference in price between states is due in large part to pricing policies under federal and state milk marketing orders. States with relatively high prices are areas where milk used as a fluid beverage (1) is priced relatively high and (2) is a relatively large share of total sales. The corresponding U.S. manufacturing price of $12.60 per cwt was equivalent to about 67 percent of the full parity price.[5/]

These prices are relatively low as the support price for milk has been set between 75 and 90 percent of parity from 1949 until the recent legislation. The 75 to 90 percent of parity range has fairly accurately reflected the long-term market clearing milk price that would bring supply and demand into balance. Because the parity price does not fully account for productivity gains in milk production, it would be expected that the long-term market clearing milk price would be, over time, equal to a lower percentage of the full parity price. For purposes of this analysis, 70 percent of parity is used as an approximation of the long-term market clearing milk price.

Six policy scenarios are compared to the base 1982 condition: milk price equal to 65 and 70 percent of parity and a flat (no classified pricing under federal milk orders) milk price equal to 70 percent of parity. A fourth

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5/ The parity price at any time is the price that would give 100 pounds of milk the same purchasing power it had during the 1910-14 period.

Table 5. Milk price under 1982 base and alternative scenarios.

State	1982 Base	Alternative scenario[a/]			
		I	II	III	IV, V and VI
	- - - -	- - - - - - -	dollars/cwt	- - - - - - -	- - - -
Minnesota	12.98	13.49	13.11	12.56	12.98
Pennsylvania	14.00	14.51	13.11	13.58	14.00
New York	13.70	14.21	13.11	13.28	13.70
Washington	13.30	13.81	13.11	12.88	13.30
Idaho	12.70	13.21	13.11	12.28	12.70
Georgia	14.40	14.71	13.11	13.98	14.40
Florida	16.40	16.91	14.71	15.98	16.40
New Mexico	14.15	14.56	13.11	13.73	14.15
Arizona	13.90	14.41	1 .11	13.48	13.90
California	13.21	13.63	13.11	12.70	13.12
U.S. Manufacturing (support)	12.60	13.11	13.11	12.18	12.60

a/ Scenarios are:

1982 Base - 1982 prices and conditions (67 percent of parity milk price).
I - Support price equal to estimated long-run market clearing price of 70 percent of parity.
II - No classified pricing for fluid milk but continuation of federal order program and a 70 percent of parity long-run equilibrium price.
III - Long-run market clearing price equal to 65 percent of parity.
IV - 1982 base price but with milk per cow equal to top 20 percent of producers using Dairy Herd Improvements in 1982.
V - 1982 base price but with higher feed prices to reflect a milk/feed price ratio of 1.38.
VI - 1982 base price but with triple charge for irrigation water used on alfalfa.

scenario evaluates the rate of return on investment for managers that achieve a milk production per cow equal to the average of the top 20 percent of producers using the Dairy Herd Improvement Association testing program in their respective states. The base 1982 prices are assumed for this scenario. A fifth scenario increased feed prices so that the milk/feed price ratio is equal to 1.38, the usual long-term relationship between feed and milk prices. The milk price in this scenario is set equal to 70 percent of parity. A sixth scenario evaluates the effect of tripling the cost of irrigation water used on alfalfa in the West and Southwest states.

The flat milk price at 70 percent of parity affects prices differently in different regions. It assumes that the farm price for milk used as a fluid beverage would fall to the manufacturing milk price in all states where milk production exceed fluid consumption by at least 25 percent (Table 5).[6] Florida is the only state of the ten considered in this report where milk production does not exceed fluid consumption by more than 25 percent. Therefore, the farm milk price in Florida is assumed to reflect transportation cost of $1.40 cwt to haul milk from surplus areas. Florida producers would be expected to receive this transportation difference because of their favorable location.

Tripling irrigation water charges would increase alfalfa production costs about $11 per ton in New Mexico and $14.70 per ton in Arizona. The same $14.70 per ton increase was assumed for California, Idaho and Washington.

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[6] Fallert, Richard F. and Boyd M. Buxton. Alternative Pricing Policies for Class I Milk Under Federal Marketing Orders - Their Economic Impact. U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service. Ag Econ Report No. 401. May 1978.

Results of Long-Term Analysis

Relative rate of return

Given the conditions under the base scenario, costs and returns for the twenty-two dairy operations were calculated. The rate of return ranged from -2.15 percent on the 52-cow New York dairy to about 15.72 percent on the 1,436-cow Florida and 900-cow New Mexico dairies (Table 6). The differences are due mostly to herd size as illustrated in Figure 3. The differences between New Mexico, Arizona and Florida (relatively high return), and California (relatively low return) in part reflect differences in milk prices.

The rate of return for the 600-cow New York dairy was favorable compared to herds of similar sizes in other states. The differences between the 600-cow Florida, 600-cow New York, 550-cow California and the 550-cow Idaho dairies are in part related to differences in milk price.

Given a long-term market clearing price of 70 percent of parity (Scenario I), the expected rate of return on all dairies would improve. However, the rate of return on the 125-cow Minnesota dairy would only increase from 2.05 to 2.63 percent while on the 900-cow New Mexico dairy it would increase from 15.63 to 17.99 percent. Generally the larger the dairies the greater the absolute increase in the rate of return for a 70 percent of milk parity price level than for the 1982 base milk price.

Eliminating classified pricing under federal milk orders (not eliminating orders themselves) likely would tend to equalize the price received by producers in all states (Scenario II). The economic implications of this policy has a differential impact depending on region. The rate of return would be about five percentage points lower on the 900-cow New Mexico dairy and the 1,436 Florida dairy and three percentage ponts lower on the 1,436-cow Arizona dairy. These

Table 6. Comparison of selected policy scenarios on the expected rate of return to investment for alternative size dairy farms in five regions.

Region/State	Herd Size	Alternative Scenarios a/ Base	I	II	III	IV	V	VI
		- - - - - - - - - - - - percent	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -
Lake States								
Minnesota	52	-1.49	-0.89	-1.25	-1.77	0.68	-0.89	-1.49
Minnesota	125	2.05	2.63	2.20	1.58	4.51	2.63	2.05
Northeast								
Pennsylvania	52	-1.72	-0.66	-2.21	-1.69	1.13	-0.07	-1.72
Pennsylvania	125	2.57	3.25	1.39	2.01	5.39	3.94	2.57
Pennsylvania	200	4.26	5.02	2.94	3.63	7.42	5.80	4.26
New York	52	-2.15	-1.58	-2.82	-2.63	-.22	-2.17	-2.15
New York	200	3.18	3.95	2.29	2.54	5.79	3.15	3.18
New York	600	7.43	8.37	6.34	6.66	10.62	7.40	7.43
Southeast								
Georgia	200	3.01	3.84	0.88	2.31	6.62	2.19	3.01
Georgia	350	5.04	5.99	2.62	4.25	9.15	4.10	5.04
Florida	350	7.46	9.14	1.89	6.08	16.08	3.18	7.46
Florida	600	9.57	11.36	3.63	8.09	18.75	5.01	9.57
Florida	1,436	15.72	17.70	9.13	14.08	25.91	10.66	15.72
Southwest								
New Mexico	900	15.63	17.99	10.82	13.69	21.87	13.54	13.17
Arizona	359	8.36	10.04	5.77	6.99	12.73	6.70	6.18
Arizona	834	11.79	13.62	8.96	10.28	16.56	9.97	9.40
Arizona	1,436	14.28	16.22	11.26	12.67	19.35	12.34	11.73
California	550	6.58	8.32	6.54	5.14	12.33	4.86	4.28
California	1,436	10.94	12.90	10.91	9.33	17.35	9.02	8.36
Northwest								
Idaho	200	4.08	5.03	4.84	3.30	7.54	3.88	4.08
Idaho	550	5.08	7.29	6.85	3.26	13.15	5.08	1.72
Washington	140	4.01	5.25	3.55	2.99	6.92	3.19	2.74

a/ Policy scenarios are:
Base - 1982 prices and construction costs.
I - Lon -term milk price of 70 percent of parity, 1982.
II - Long-term milk price of 70 percent of parity, but flat pricing in all regions.
III - Long-term milk price of 65 percent of parity.
IV - Milk production per cow equal to top 20 percent of Dairy Herd Improvement Association Producers, 1982.
V - Long-term milk price of 70 percent of parity but with higher feed prices to reflect a milk/feed price ratio of 1.38.
VI - Triple water cost for irrigating alfalfa in New Mexico, Arizona, California, Idaho and Washington.

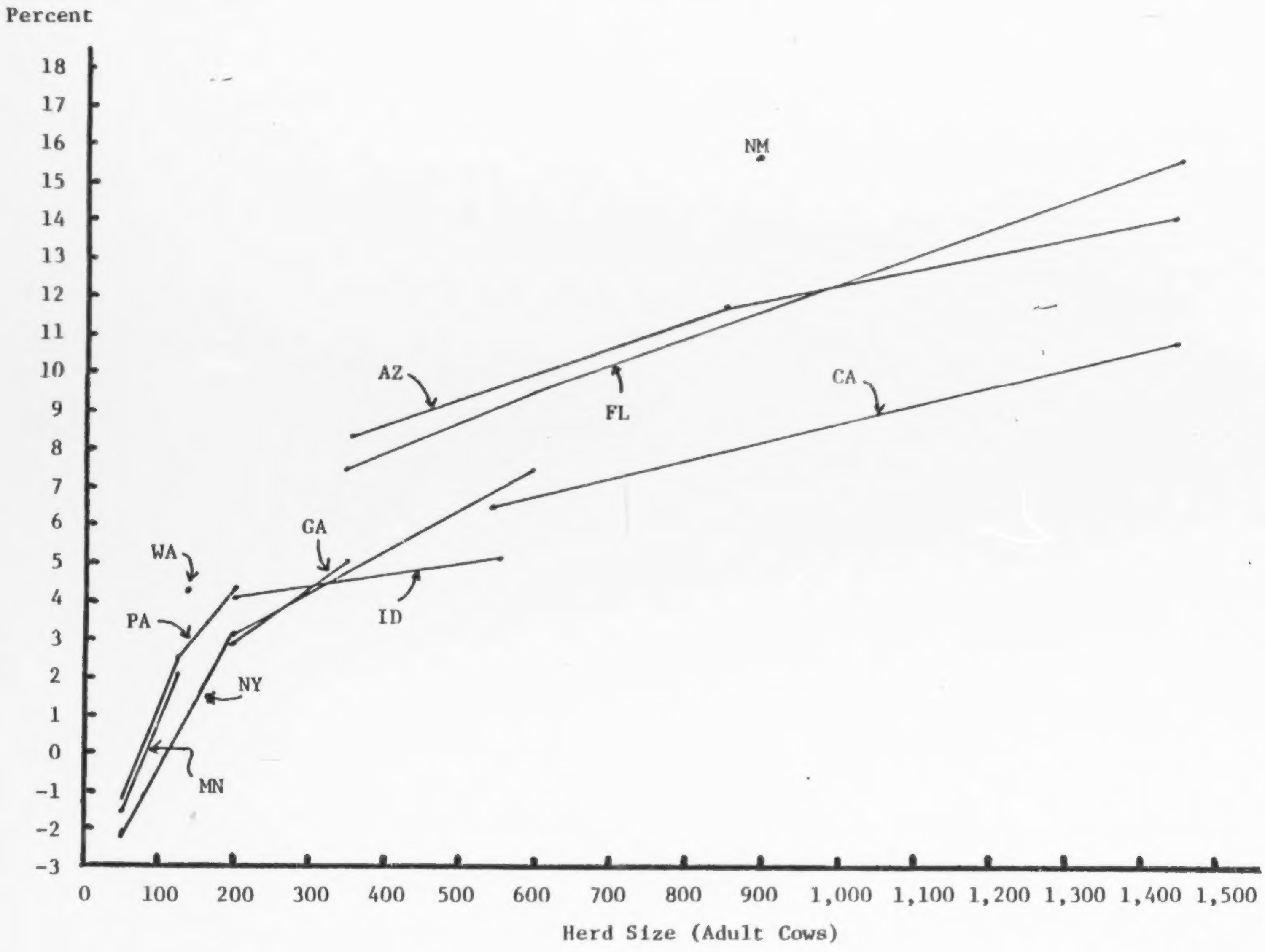

Figure 3. Long-term rate of return to investment by herd size and state.

These are areas where the decrease in milk price would be relatively large. The rate of return would be reduced about one percentage point in the Northeast and Northwest regions but basically unaffected in the Lake States.

A sixty-five percent of parity long-term milk price would be somewhat less favorable than existed in 1982 (Scenario III). The rate of return would be less favorable than under the base 1982 conditions.

Dairy producers who are able to achieve a level of milk production per cow equal to the top 20 percent of the producers using the Dairy Herd Improvement Association testing program would greatly improve their expected rate-of-return (Scenario IV). The rate of return would increase as much as 10 percentage points for a 1,436-cow Florida dairy (Table 6). The level of milk production per cow and concentrates fed per cow are shown in Table 7.

Using the long-term 70 percent of parity milkprice and a corresponding level of feed prices that reflect the long term milk/feed price ratio of 1.38 (Scenario V), reduces the rate of return in the Southeast, Southwest and Northwest regions relative to the Lake States and Northeast regions (Table 6). The rate of return is lower by about 7 percentage points for the 1,436-cow Florida dairy, 4 percentage points for the 1,436-cow Arizona and California dairies but nearly unaffected for the Lake States and Northeast dairies. The biggest impacts are for those dairies that purchase a large part of the feed requirement.

Tripling charges for irrigation water and resulting higher cost for alfalfa hay, reduced the rate of return 2 to 3 percentage points below the base scenario in the Southwest and Northwest regions (Scenario VI).

Table 7. Concentrates fed and milk production per cow for top 20 percent of DHIA producers, 1982[a/]

State	Concentrates Fed	Milk Per Cow
Minnesota	5,563	17,726
Pennsylvania	5,979	18,322
New York	5,012	18,144
Washington	6,450	19,000
Idaho	5,945	18,177
Georgia	6,779	15,897
Florida	11,019	15,897
New Mexico	6,927	18,169
Arizona	7,501	18,659
California	7,506	19,145

a/ Forage fed is the same as in base (see Table 3).

Adjusted cost per cwt

A cost per cwt of milk (adjusted for sales other than milk) tended to be lower on large than on small dairies in all states (Figure 4). Also costs were lower on the very large dairies in California, New Mexico, Arizona, and Idaho than on smaller dairies in Minnesota, Pennsylvania, and New York. However, the 600-cow New York dairy had comparable costs to herds of about that size in other states.

The major exception was the relatively high cost for Florida dairies. Floridas' high costs are in part offset by relatively high milk prices resulting in the competitive rate of return on investment discussed in the previous section and illustrated in Figure 3.

The cost per cwt of milk is nearly the same for alternative price support or federal order policy scenarios. However, costs per cwt drop dramatically for producers achieving milk production per cow equal to the top 20 percent of producers using DHIA tests compared to a producer achieving the average of all producers using DHIA tests (Table 8).

Conclusions of long-term analysis

A rate of return to investment is calculated for twenty-two dairy farms after all operating costs are paid and sufficient money withheld to maintain the long-term viability by replacing worn out equipment and facilities. The major findings of the analysis include the following:

1. Investment per cow in dairy buildings and equipment is less on larger than on smaller dairies.

2. For the herd sizes that characterizes dairy farming in each region, investment per cow is less for the large dairy operations in the Southwest, Northwest and Southeast than for the Lake State and Northeast regions.

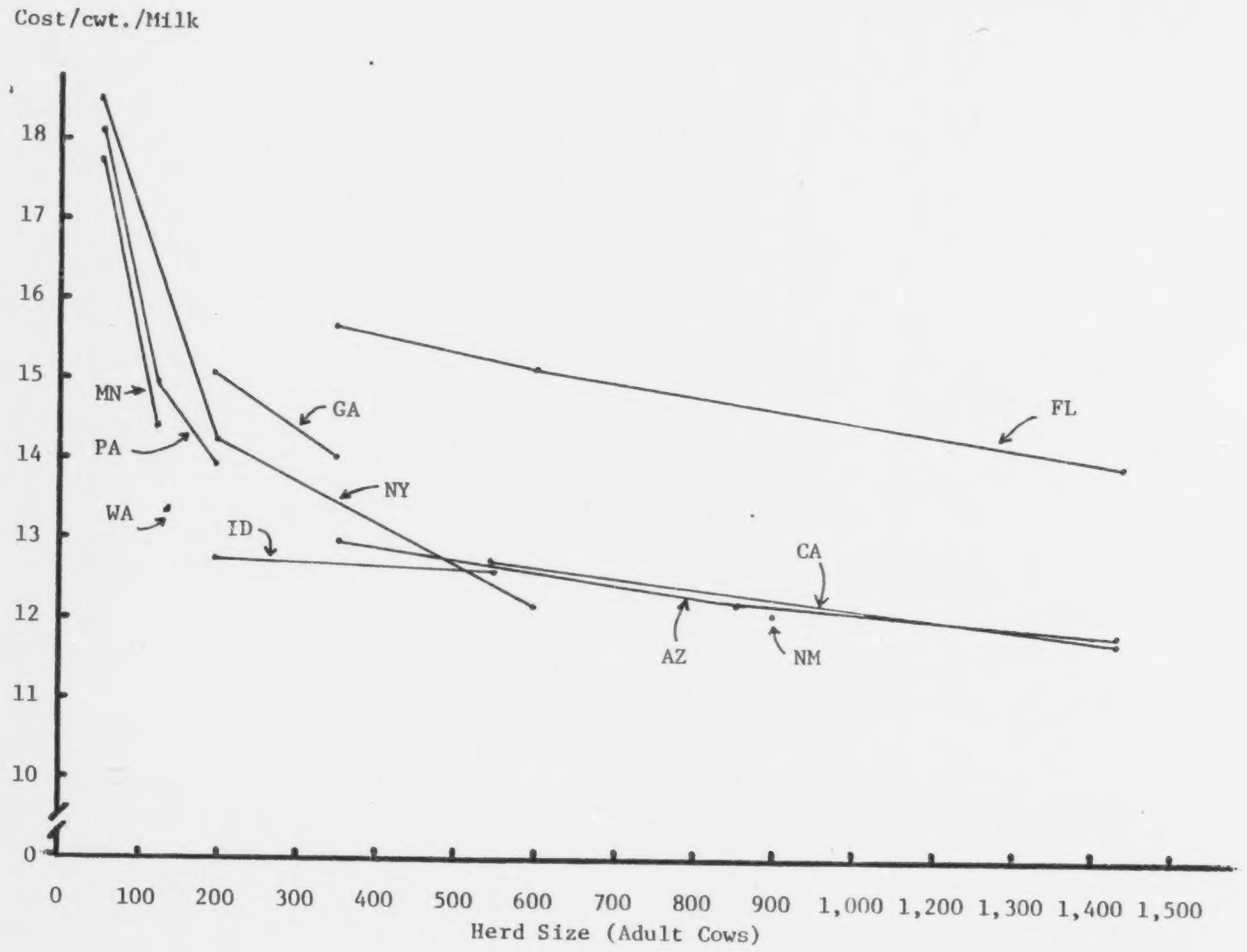

Figure 4. Total cost per cwt. of milk by herd size and state, 1982.

3. Based on whole farm budgets, the larger dairies with 500 cows or more are more profitable than smaller dairies. Considering the long-term, effeciently operated dairies in New Mexico, Arizona and Florida are more profitable than their counterparts in California, Idaho, Minnesota and the Northeast. This result is the bottom line after reflecting regional difference in costs and milk prices received.

4. Although costs per cwt of milk are highest in Florida, the relative high price received for milk provides a competitive return. The profitability of California and Idaho dairies is adversely affected by lower milk prices compared to New Mexico, Arizona and Florida dairies.

5. Strong economic pressure exists for herds to get larger in all regions. This will continue the trend to fewer and larger dairies.

6. The relatively favorable profit potential (rate of return) of large scale dairy farming in the Southwest, Southeast and Northwest regions will likely result, over the long term, in a continued shift in milk production to those areas. Those areas will likely increase their relative share of total U.S. milk production, placing increased competitive pressure on the traditional Lake States and Northeast dairy areas.

7. The profitabiity of dairy farming is greatly improved in all regions when management achieves production per cow levels equal to the top 20 percent of the farmers using Dairy Herd Improvement Testing programs (Scenario V). Achieving these performance levels tends to improve the profitability of large more than small dairies, adding more economic incentive for large scale dairying.

Table 8. Impact of higher milk production per cow on adjusted cost per cwt.

Region/State	Herd Size	Base	Top 20%
	(cows)	- - - - - dollars	- - - - -
Lake States			
Minnesota	52	17.71	15.46
Minnesota	125	14.43	12.66
Northeast			
Pennsylvania	52	18.09	15.89
Pennsylvania	125	14.97	13.24
Pennsylvania	200	13.92	12.35
New York	52	18.46	16.54
New York	200	14.25	12.86
New York	600	12.20	11.06
Southeast			
Georgia	200	15.04	13.30
Georgia	350	14.06	12.48
Florida	350	15.65	13.80
Florida	600	15.19	13.41
Florida	1,436	13.93	12.35
Southwest			
New Mexico	900	12.06	11.19
Arizona	359	12.98	12.02
Arizona	834	12.26	11.37
Arizona	1,436	11.81	10.96
California	550	12.68	11.46
California	1,436	11.77	10.68
Northwest			
Washington	140	13.38	12.42
Idaho	200	12.75	11.35
Idaho	550	12.63	12.25

8. Retaining milk marketing orders but realigning the level of class I fluid milk prices (Scenario II) to be the same (flat) in all areas with surplus fluid milk, would adversely effect profitability in the Southeast, Southwest, Northwest and Northeast relative to the Lake States.

9. Increasing charges for irrigation water to more closely reflect actual costs narrows the gap in estimated rate of return between the Southwest and Northwest regions and other regions that do not heavily rely on irrigation water by 2 to 3 percentage points.

TEN YEAR IMPACT OF ALTERNATIVE POLICIES

The preceeding section considered the long-term relative rates of returns of different size dairies in five regions. Implicit in the analysis is that the real production costs will remain constant and the support price cannot be permanently above or below the price level that will balance supply and demand. Under the present purchase type price support program, decisions to set support prices above the long-term market clearing level would, in the long-run, have to be modified. Otherwise the government expenditures would grow to a level unacceptable to policymakers. This means that alternative support levels must reflect market conditions in the long run.

This section considers the economic impacts of selected policy decisions on dairy operations over a ten year period. A panel of dairy scientists identified likely new technologies that would be available over the next ten years, the adoption rate by the industry, and the impact on milk production per cow.[7/] Adoption of new technology would reduce the real cost of producing milk. In turn lower real costs of production would be reflected in lower milk prices. A

[7/] Congressional Office of Technology Assessment, Animal Technology Workshop. Washington, D.C., April 1984.

description of these technologies are presented later in this report. Eight of the twenty-two dairy operations analyzed in the previous section were selected to analyze the impact of alternative technologies and policies. Three of the five regions are represented: Lake States, Southeast and Southwest.

Dairy Simulation

A Firm Level Income Tax and Farm Policy Simulator was used to stocastically simulate the eight dairy operations for selected policy and technology scenarios for 10 years beginning in 1983.[8/] The planning horizon was simulated 50 times (iterations) using a different set of random milk, cull cow and replacement cow prices, feed costs and milk production per cow for each iteration. At the end of each iteration, values for present value of net returns (revenue minus cost over ten year period) and ending net worth, long-term and intermediate-term debt, equity to asset ratio, internal rate of return and net farm income were calculated.

Evaluation Criteria

The FLIPSIM V model provides considerable detail as to the viability of a representative farm at the end of each iteration, e.g., leverage ratio, net worth, total assets, total debt, net present value, and whether the dairy remained solvent for 10 years. By repeating each scenario for 50 iterations, the model generates the information necessary to estimate the probability distributions for key output variables. The means of these key output distributions are used to compare the economic impacts of selected policy and technology scenarios on specific dairies. The following output

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[8/] Richardson, James W. and Clair J. Nixon. Description of the Computer Program for Flipsim V: The Firm Level Income Tax and Farm Policy Simulator. Ag. Experiment Station, Texas A & M University. January 1984.

variables for the model were selected to compare the impacts of the scenarios described in the following sections.

* Probability of survival is defined as the probability that the representative farm will remain solvent for 10 years. In other words, it is the probability that the farm operator would maintain at least the minimum financial ratios required by bankers in the local area for all years of the 10 year planning horizon.
* Probability of a positive after-tax net present value. An after-tax, real discount rate of 3% was used to calculate the farm's net present value. Thus this statistic indicates the probability of the representative farm providing at least a 3% real rate of return on the initial investment.
* After-tax net present value is the net present value of the operator's annual cash withdrawals plus the present value of the change in net worth for the total operation minus the present value of annual off-farm income. A 3% after-tax, real discount rate was used to calculate net present value for all representative dairies.
* Present value of ending net worth measures the present value of the financial growth for a dairy over the 10 year planning horizon. Net worth is affected by increases or decreases in asset (land, machinery, and livestock) value and retained earnings. This value can be compared directly to each diary's initial net worth (Table 9) to indicate the relative magnitude of financial growth.
* Total debt at the end of the planning horizon is recorded for each iteration. This value provides an insight into the financial stress of the dairy over the planning horizon. Increases in average ending

debt from one scenario to another can be due to the dairy operator being forced to refinance large cash flow deficits. When surplus cash is available, the operator is permitted to prepay intermediate-term debts.

* Ending equity ratio is the ratio of ending net worth to ending assets for each iteration. This ratio provides a measure for comparing the representative dairies ending financial position across scenarios.
* Internal rate of return for the representative dairy is calculated at the end of each iteration. The internal rate of return is the real discount rate which makes the present value of the operator's annual cash withdrawals and change in net worth equal zero.

Base Scenario

The base scenario assumptions are those considered most likely over the ten year planning horizon and are summarized in the following sections.

Technology

The impact of productivity gains achieved through new technologies and management practices are largely reflected in increased milk production per cow and reductions in the real cost of producing milk. In the longer-run, lower production costs are largely passed on to consumers through lower milk prices. Dairy farmers who adopt technology and achieve productivity gains are able to compete and remain financially solvent while those farmers that do not likely will become insolvent.

The pooled knowledge and judgement of the above mentioned panel of animal scientists identified the most likely new technologies and adoption rates and productivity gains over the 1983 to 1992 perod. Although milk production per cow is expected to increase for all herd sizes in all regions, the pannel of scientists expected operators of larger herds within each region to adopt new technology more rapidly than operators of smaller herds. While the 125-cow dairy is considered very large in Minnesota, it would be considered very small in California, Arizona or Florida. However, operators of the very large 125-cow Minnesota dairies are expected to adopt new technology as rapidly as operators of the very large 1,436-cow dairies in California and Florida (Table 9).

Milk production per cow is expected to continue a long term trend by increasing one percent annually for all herd sizes (Table 10). New technology likely to increase milk production above this long-term trend was grouped into three main categories: (1) Information and nutrition including such technologies as computer management and feeding systems, growth regulators, communication and information systems, and improved environmental management; (2) bovine growth hormone (bgh); and (3) other biotechnologies including embryo transplants and sexing, genetic engineering, and pest and disease control.

Information and nutrition technologies are expected to increase milk production per cow an additional 1.8 percent annually starting in 1983 for very large dairies, 1985 for large dairies and 1987 for medium size dairies (Table 10).

Bovine growth hormone is expected to increase milk per cow 25.6 percent when adopted. This jump in milk production per cow is expected to continue after being adopted in 1987 by operators of very large dairies, 1988 by operators of large dairies and in 1989 by operators of medium size dairies. The favorable economic incentives suggest a more rapid adoption than other technology groups once bgh is available.

Table 9. Very large, large and medium herd sizes by state.[a/]

State	Herd size (adult milk cows)		
	Very Large	Large	Medium
Minnesota	125	*	52
California	1,436	550	*
Arizona	*	*	359
Florida	1,436	600	350

* Dairies for these herd size groups were not simulated.

a/ Size groups based on market order data, see footnote 1 for source.

Table 10. Year-to-year percentage increase in milk production per cow in trend and three technology groups, 1983-1992. a/

Year	Trend	Information and Nutrition			Bovine Growth Hormone			Other Biotechnologies		
		VL	L	M	VL	L	M	VL	L	M
	percent b/									
1983	1.0	1.8	0	0	0	0	0	0	0	0
1984	1.0	1.8	0	0	0	0	0	0	0	0
1985	1.0	1.8	1.8	0	0	0	0	0	0	0
1986	1.0	1.8	1.8	0	0	0	0	0	0	0
1987	1.0	1.8	1.8	1.8	25.6	0	0	0.5	0	0
1988	1.0	1.8	1.8	1.8	0	25.6	0	0.5	0	0
1989	1.0	1.8	1.8	1.8	0	0	25.6	0.5	0.5	0
1990	1.0	1.8	1.8	1.8	0	0	0	0.5	0.5	0
1991	1.0	1.8	1.8	1.8	0	0	0	0.5	0.5	0.5
1992	1.0	1.8	1.8	1.8	0	0	0	0.5	0.5	0.5

a/ VL = Very large herds; L = Large herds; M = Medium size herds.

b/ Percentage increases are for specified year and are maintained in all subsequent years. Percentage increases are above 1982 production per cow levels of 147.1 cwts in Minnesota, 165.7 cwts in California and Arizona, and 131.1 cwts in Florida.

Source: Congressional Office of Technology Assessment, Animal Technology Workshop. Washington, D.C., April 1984 and Koller, Robert J. et al. Biotechnology and the Dairy Industry: Production Costs and Commercial Potential of the Bovine Growth Hormone. Cornell University Center for Biotechnology. AE Research 84-22. December 1984.

Increased feed costs per hundredweight of milk due to bgh is estimated at $4.49 for California, Arizona and Florida dairies and $3.59 for Minnesota dairies. About 90 percent of the increased feed cost would be for concentrates and 10 percent for forage. The cost is less in Minnesota because of lower concentrate prices than in other states.

The other biotechnology group is expected to increase milk production per cow an additional 0.5 percent annually starting in 1987 for very large dairies, in 1989 for large dairies and in 1991 for medium size daries (Table 10).

Table 11 summarizes the expected milk production per cow for various size herds in three regions, given the above technology assumptions.

Milk Prices

The base scenario assumes the support price specified in the Dairy and Tobacco Production and Stabilization Act of 1983. The 1984 price likely will be 32 cents lower than 1983 reflecting a 50 cent reduction in the support price on December 1 of 1983. The government purchases of surplus dairy products are assumed to be high enough through 1985 and 1986 to trigger a 50 cent drop in support price on April 1, 1985, and again on July 1, 1985, as specified in the above mentioned Act of 1983. This price is projected on through 1986. All features of the Act of 1983 are scheduled to expire on September 30, 1985.

For 1987 to 1992 the dairy support price is reduced 50 cents per year as long as the estimated variable milk production costs, given assumed technological changes and associated declines in real costs, are less than market prices in the previous year. It is expected that the 50 cent per hundredweight declines will occur through 1992 (Table 12). The prices in Table 12 are "all" milk prices by states corresponding to the assumed support price for manufacturing grade milk.

Table 11. Milk production per cow for most likely technology scenario, 1982 to 1992.

Year	Minnesota		California and Arizona			Florida		
	Very Large	Medium	Very Large	Large	Medium	Very Large	Large	Medium
	hundredweight							
1982	147.1	147.1	165.7	165.7	165.7	131.1	131.1	131.1
1983	151.2	148.6	170.3	167.3	167.3	134.8	132.4	132.4
1984	155.5	150.0	175.1	169.0	169.0	138.6	133.7	133.7
1985	159.9	151.5	180.1	173.0	170.0	142.5	137.5	135.0
1986	164.3	153.1	185.1	178.6	172.0	146.4	141.3	136.5
1987	169.0	157.2	190.4	183.6	177.1	150.6	145.3	140.1
1988	225.4	161.7	253.8	188.7	182.1	200.8	149.3	144.1
1989	232.9	166.4	262.3	252.0	187.4	207.5	199.4	148.3
1990	240.7	221.9	271.0	260.0	260.0	214.5	206.1	197.8
1991	248.6	229.3	280.0	269.1	258.3	221.6	212.9	204.4
1992	256.8	237.1	289.3	278.0	267.1	228.9	219.9	211.3

Table 12. "All" milk price per hundredweight for base scanario, 1983 to 1992.

Year	Minnesota	Arizona	California	Florida
	------------------------- dollars -------------------------			
Base				
1983	12.94	13.90	13.06	16.50
1984	12.62	13.54	12.98	16.09
1985	12.12	13.02	12.23	15.45
1986	12.12	13.02	12.23	15.45
1987	11.62	12.48	11.73	14.82
1988	11.12	11.94	11.22	14.18
1989	10.62	11.41	10.72	13.54
1990	10.12	10.87	10.21	12.90
1991	9.62	10.33	9.71	12.27
1992	9.12	9.80	9.20	11.63
No support program				
1983	12.94	13.90	13.06	16.50
1984	12.62	13.54	12.98	16.09
1985	12.12	13.02	12.23	15.45
1986	10.38	11.09	10.43	13.18
1987	10.04	10.73	10.09	12.75
1988	8.96	9.58	9.00	11.38
1989	8.48	9.07	8.52	10.77
1990	8.26	8.83	8.30	10.49
1991	8.45	9.03	8.49	10.73
1992	8.60	9.19	8.64	10.92

To evaluate a no dairy price support scenario, milk price is expected to fall to the estimated average variable cost for the most efficient dairies until 1990. Price is then expected to recover in 1991 and 1992 until in 1992, the price is equal to the average total cost for the most efficient dairies (Table 12). However, with no price support program, the actual price may be either above or below the average price. The similator randomly selects milk prices from a distribution that may be as much as 20 percent above or 25 percent below the mean price.[9]

In addition to the milk price, the prices of cull cows, replacement heifers, and feed, and production per cow are assumed to be stochastic over the ten year period. Random values for these variables are drawn from an estimated multivariate empirical probability distribution. The correlation matrix on which the multivariate distribution is based is shown in Table 13.

Non-Stochastic interest rates used in the simulation model were:

Old long-term loans ---------- 8.5 percent
Old intermediate loans ------- 13.0 percent
New long-term loans ---------- 11.5 percent
New intermediate loans ------- 13.26 percent
Refinance long-term loans ---- 13.00 percent
Refinance intermediate loans - 13.26 percent
Operating loans -------------- 10.0 percent
Received for cash reserves --- 10.0 percent

Zero inflation rate was also assumed over the ten year planning horizon (all prices in 1983 dollars).

The dairies are not allowed to increase herd size over the ten year period. The crop mix on dairies producing some or all the feed is assumed to be constant.

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[9] The variation of milk prices without a dairy price support program was developed from the following study: Thraen, Cameron S. and Jerome W. Hammond. *Price Supports, Risk Aversion and U.S. Dairy: An Alternative Perspective of the Long-Term Impacts*. Economic Report ER83-9, Department of Agricultural and Applied Economics, University of Minnesota. June 1983.

Table 13. Correlation between stochastic variables used in the dairy simulations.

Region/Variable	Milk Price	Cull Cow Price	Replacement Cow Price	Milk/ Cow	Feed Cost
Lake States					
Milk price	1.000	.887	.594	.403	-.435
Cull cow price		1.000	.777	.277	-.302
Replacement cow price			1.000	.3137	.234
Milk/cow				1.000	-.464
Feed price					1.000
Southeast					
Milk price	1.000	.202	.461	.401	.836
Cull cow price		1.000	-.807	-.040	-.221
Replacement cow price			1.000	-.197	.222
Milk/cow				1.000	.068
Feed price					1.000
Southwest					
Milk price	1.000	-.162	-.067	-.549	.004
Cull cow price		1.000	.963	.407	-.206
Replacement cow			1.000	.187	-.169
Milk/cow				1.000	-.328
Feed price					1.000

Financial Characteristics

The likelihood of a particular dairy remaining solvent under alternative policies is directly affected by its initial financial characteristics. The characteristics of most importance include the value of assets, cash reserves, debt, net worth, equity and family consumption needs. A policy change can have quite different implications for the operator of a dairy with a high level of debt than one with a low level of debt.

The average financial situation that exists on the eight dairies of the size and location selected are shown in Table 14. The averages were approximated from a U.S. Department of Agriculture farm financial survey.[10/] Equity ranged from 69 to 76 percent of total assets. In contrast to replacement values used in the previous section, the value of buildings and machinery are market values and assumes each asset is about half depreciated.

Other Assumptions

The following options for depreciating machinery and calculating income taxes are used for the base scenario.

* Machinery, livestock, and buildings placed in use prior to 1981 are depreciated using the double declining balance method.
* Machinery, livestock, and buildings placed in use after 1980 are depreciated using an accelerated cost recovery method.
* The operator elects to claim first year expensing for all depreciable items placed into use after 1980.

10/ Summary of financial characteristics of dairy farms were estimated from farm financial summary data provided by Neil Peterson, ERS, USDA.

Table 14. Financial characteristics assumed for eight dairy operations in four states.

Financial Characteristics	Minnesota		AZ	California		Florida		
	52	125	359	550	1,436	350	600	1,436
Value of								
Cropland and Farmstead ($1,000)	293.4	679.1	39.4	160.0	312.0	262.5	450.0	1,074.0
Buildings ($1,000)	92.7	176.7	192.8	284.4	512.6	87.9	108.9	211.7
Farm Machinery ($1,000)	104.1	159.0	120.3	183.1	303.0	114.6	180.0	260.7
All Livestock ($1,000)	77.9	181.4	599.6	960.7	2,505.0	525.5	981.4	2,344.3
Off Farm Investments ($1,000)	5.5	13.1	0	0	0	0	0	0
Beginning Cash Reserves ($1,000)	12.0	62.5	89.8	137.5	35.9	70.0	212.0	505.5
Debt ($1,000)	268.3	302.4	297.7	464.3	1,130.0	303.7	461.9	944.6
Initial Networth ($1,000)	417.1	969.4	744.2	1,261.3	2,537.5	756.9	1,464.7	3,343.0
Equity Ratio (Fraction)	.71	.76	.71	.73	.69	.71	.76	.76
Family Living								
Minimum ($1,000)	20.0	25.0	25	27	30	25	27	30
Maximum ($1,000)	32.0	35.0	30	38	40	30	38	40
Marginal Propensity (Fraction)	.3	.4	.3	.4	.4	.35	.4	.4
Off Farm Income ($1,000)	0	0	0	0	0	0	0	0

- The operator elects to take maximum investment tax credit (ITC) and thus reduce the basis for all depreciable assets placed into service after 1980.
- The operator may use either the regular income tax computation or income averaging to calculate federal income tax liabilities.
- There is no maximum interest deduction under the federal income tax codes.
- The actual self employment tax rates and maximum income levels subject to this tax for 1983 and 1984 are used. Announced values for these variables in 1985-1986 were used and the 1986 values were held constant through 1992.
- The operator elects to trade obsolete machinery in on new replacements.

Policy and Technology Scenarios

Policy scenarios

The eight dairy operations were simulated under alternative technology and policy scenarios. The assumptions and policy values associated with each scenario were held constant across all dairies to allow direct comparison of their impacts on different size dairies in different regions.

Two financial bailout scenarios (interest subsidy and debt restructuring) were evaluated for the Minnesota 52-cow and 125-cow, Arizona 359-cow and Florida 350-cow dairies assuming an initial high debt position and assuming a new entrant with high debt position. Each scenario is described in this section.

A 20% acreage reduction--The present feed grain program was assumed through 1985. From 1986 to 1992 a 15% set aside with a 5% diversion for corn, cotton, rice, sorghum, and wheat was assumed. Normal slippage (30% for corn and 70% for all other crops) and program participation rates were used to estimate the resulting real increase in mean prices for these crops from 1986 to 1992. This program results in dairy feed prices being 9 percent higher than under the base scenario.

Feed cost represents about 50 to 60 percent of total costs per cow. A crop program that results in a higher feed cost would have an adverse impact on a dairy's ability to increase net worth, reduce debts, and to achieve as high an internal rate of return. In the short-run, operators that raise most of the feed fed on these dairies would be largely unaffected.

No crop program--The CCC loan, farmer owned reserve, and target price provisions were eliminated for all years in the planning horizon (1983-1992). This increased the variability in feed costs facing dairy operations. Feed prices paid by dairies would be higher in some years but lower in other years. Over time, high and low price years would be expected to about balance out, leaving a surviving dairy about as well off as under the base scenario. However, the cost associated with possible borrowing to tide a dairy over periods of high feed costs would be expected to somewhat adversely affect its ability to retire debt and increase net worth. Dairies under tight financial conditions in the base scenario, would be expected to have a lower probability of survival without crop programs because they would be less able to absorb the effects of periods of relatively high feed prices. The impact of this increased variability is evaluated.

Fifty cents lower price--All the assumptions of the base scenario are retained except the mean milk prices are reduced 50 cents per cwt and the variability of milk price above support increased. Lower support prices would be expected to adversely impact debt retirement, gains in net worth and internal rate of return of all dairies. The ability of a dairy to survive this adverse effect on revenue depends, as explained above, on the financial position of the dairy under the base scenario. The less favorable financial position a dairy faces under the base scenario, the greater the decrease in the probability that the dairy will survive.

No dairy price support--All assumptions of the base scenario are retained except milk price variability was increased. Milk prices have a ten percent chance of being 20 percent higher or 25 percent lower than the base mean price. The mean prices are kept the same as in the base scenario. The simulation results show the impact of increased variability in milk prices. Without a dairy price support program there would be no guaranteed price floor. In some years milk price would be higher while in other years it would be lower than under the base scenario. Generally, the milk price would be lower under no price support program than under the base (Table 12). Over time favorable and unfavorable prices should tend to balance out meaning that the ability of a dairy to increase net worth, repay debt, and achieve a favorable internal rate of return would not be seriously affected. However, the probability of survival for dairies in tight financial situations under a base scenario could be adversely affected as a period of unfavorable milk prices might cause the dairy to become insolvent before favorable prices returned.

Income tax changes--All assumptions of the base scenario are retained except for more restrictive federal income tax provisions including:

* Machinery, livestock, and buildings were depreciated using the straight line cost recovery method.

* First year expensing provisions were eliminated for all depreciable items.

* Maximum Investment Tax Credit provisions were eliminated.

- * The maximum annual interest expense which could be used to reduce taxable income was $15,600.
- * The operator must sell obsolete machinery upon disposition rather than trading it in on new replacements, thus forcing recapture of excess depreciation deductions.

These tax policy changes would all have an adverse impact on the ability of a dairy to reduce debt, increase net worth, and, if in a tight financial situation under the base scenario, reduce the probability of survival. An increase in tax liability, would reduce the net income of the dairy leaving less for debt retirement and increases in net worth.

Supply control--All assumptions of the base scenario are retained except mandatory quotas are imposed on dairies. Quotas equal to 96.5 percent of a producers normal production would, over time, be expected to maintain milk prices $1 above those in the base scenario. Cow numbers would be reduced about 4 percent in order to reduce milk production 3.5 percent assuming poorer than average cows would be culled in complying with the quota.

The financial performance of all dairies likely would be improved with permanently higher milk prices despite having to reduce total milk produced within the designated quota. The probability of survival would increase along with a greater ability to reduce debt and increase net worth for dairies existing at the time the program is implemented. However, this economic advantage could be capitalized into quota value eroding the advantage for new entrants or producers that would have to purchase quotas to expand milk production.

Technology scenario

The milk price assumption of the base scenario is retained for the two technology scenarios discussed below. It should be recognized that milk prices would be expected to be higher than the base scenario prices should productivity gains from the designated technologies not materialize. Therefore the adverse affect of these technology scenarios is overstated.

No information and nutrition--The 1.8 percent annual increase in production per cow attributable to information and nutrition technology is excluded from the base assumption for this scenario (Table 10). The financial performance of all dairies would be adversly affected under this scenario. For the very large farms the per cow increase in 1982 milk production per cow by 1992 is only two-thirds as much as under the base scenario (Table 15).

No bovine growth hormone--The 25.6 percent jump in milk production when adopted is excluded from the base assumption for this scenario (Table 10). The financial performance of all dairies would be adversly impacted under this scenario compared to the base. For the very large dairies, the increase in 1982 milk production per cow by 1992 is only 40 percent as much as under the base scenario (Table 15).

Financial stress scenarios

The assumed beginning financial conditions for four of the eight dairies were changed to reflect high debt operators and new entrants with high debt operators (Table 16). Debt load was about doubled to reflect high debt situations. For new entrants all equipment is assumed to be new which increases both the initial value of machinery and the total debt load.

Two policy alternatives are considered for high debt dairies. One is to subsidize interest rates on all debt so the effective rate for all loans paid would be 8 percent rather than the higher rates used in the base. The second is to convert a portion of intermediate debt into long-term loans and/or to extend the length of intermediate-term loans. In the second case, interest

Table 15. Accumulated percent increase in milk production above 1982 for base scenario, and two scenarios without technology gains, very, large, large and medium size dairies, 1983 to 1992.a/

Year	Very Large			Large			Medium		
	Base	No Information & Nutrition	No bgh	Base	No Information & Nutrition	No bgh	Base	No Information & Nutrition	No bgh
	---------- accumulated percent increase above 1982 production ----------								
1983	2.8	1.0	2.8	1.0	1.0	1.0	1.0	1.0	1.0
1984	5.7	2.0	5.7	2.0	2.0	2.0	2.0	2.0	2.0
1985	8.7	3.0	8.7	4.9	3.0	4.9	3.0	3.0	3.0
1986	11.7	4.1	11.7	7.8	4.1	7.8	4.1	4.1	4.1
1987	14.9	5.1	14.9	10.8	5.1	10.8	6.9	5.1	6.9
1988	53.2	35.3	18.7	13.9	6.2	13.9	9.9	6.2	9.9
1989	58.3	37.3	21.4	52.1	34.6	17.2	13.1	7.2	13.1
1990	63.6	39.4	24.9	57.2	36.7	20.4	50.9	36.0	16.3
1991	69.0	41.5	28.4	62.4	38.7	23.8	55.9	38.0	19.5
1992	74.6	43.6	32.0	67.8	40.8	27.3	61.2	40.1	22.9

a/ To determine milk production per cow, apply the percentage increase in the table to 147.1 cwts in Minnesota, 165.7 cwts in California and Arizona, and 131.1 cwts in Florida.

Table 16. Percentage change in initial financial position to reflect dairies in initial high debt and for new entrants with high debt positions.

Financial Characteristic	Herd Size							
	High Debt				New Entrant			
	MN 52	MN 125	AZ 359	FLA 350	MN 52	MN 125	AZ 359	FLA 350
	percent change[a/]							
Value								
Cropland & Farmstead ($1,000)	0	0	0	0	0	0	0	0
Buildings ($1,000)	0	0	0	0	0	0	0	0
Farm Machinery ($1,000)	0	0	0	0	138	168	167	209
All Livestock ($1,000)	0	0	0	0	0	0	0	0
Off Farm Investments ($1,000)	0	0	0	0	0	0	0	0
Beginning Cash Reserves ($1,000)	0	0	0	0	0	0	0	0
Debt								
Long-Term ($1,000)	108	148	107	46	143	180	141	71
Intermediate-Term ($1,000)	91	131	88	140	242	311	139	230
Initial Worth ($1,000)	-41	-43	-42	-38	-37	-41	-29	-30
Equity Ratio (Fraction)	-41	-42	-37	-38	-49	-51	-41	-42
Family Living								
Minimum ($1,000)	0	0	0	0	0	0	0	0
Maximum ($1,000)	0	0	0	0	0	0	0	0
Marginal Propensity (Fraction)	0	0	0	0	0	0	0	0
Off Farm Income	0	0	0	0	0	0	0	0

a/ Change from initial values shown in Table 9.

rates, total debt loads, and other assumptions of the high debt dairies remain the same as in the base.

The impact of changes in crop programs (20 percent acreage reduction) resulting in nine percent higher feed prices and eliminating the dairy price support program are evaluated for new entrants with high debt position.

Results for Alternative Policy and Technology Scenarios

52-cow Minnesota dairy

Given the base policy scenario, the 52-cow Minnesota dairy had a 74 percent chance for survival after ten years but only a 26 percent chance of having a positive after tax, net present value (Table 17). Average present value of ending net worth decreased from the initial $417,000 to $240,000 after ten years. Total debt increased $199,000 and the equity to asset ratio declined from 0.71 to 0.44 over the ten year period. Average annual net farm income was a negative $22,000.

Both policy alternatives involving crop programs that increase feed prices (Scenario I) and the no crop program that increases feed price variability (Scenario II) have little impact on the 52-cow Minnesota dairy because most of the feed is raised rather than purchased on the Minnesota dairy. Crop yields were fixed and not variable from year-to-year. However, simulations where crop yields were stochastic did not significantly change the results.

A support price 50 cents below the price in the base scenario reduces the probability of survival from 74 percent to 56 percent (Scenario III). The decline in the present value of ending net worth is more adversely affected and debt is $36,000 higher compared to the base after ten years.

Eliminating the price stabilizing aspects of the dairy price support program (Scenario IV) would result in a probability of survival of 22 percent

Table 17. Comparison of Selected Policy Scenarios on a 52-Cow Minnesota Dairy

Criteria	Initial Situation	Alternative Scenarios[a]								
		Base	I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	NA	74	62	74	58	22	74	92	50	62
Probability of Positive Net Present Value (%)	NA	26	22	26	18	8	24	38	20	22
After-tax net present value mean ($1,000)	NA	-61	-89	-61	-100	-198	-62	13	-103	-88
Average present value of ending net worth ($1,000)	417	240	213	240	202	114	238	310	191	214
Total Debts After 10 Years ($1,000)	168	367	392	367	403	443	370	309	400	391
Average ending equity ratio (fraction)	0.71	0.44	0.39	0.44	0.37	0.22	0.43	0.55	0.35	0.39
Average internal rate of return (fraction)	NA	-0.02	-0.03	-0.02	-0.04	-0.09	-0.02	0.01	-0.04	-0.03
Average annual net farm income ($1,000)	NA	-22	-25	-22	-27	-38	-27	-14	-26	-25

[a] The scenarios are:
Base -- Continuation of present policy
I -- A 20% acreage reduction crop program - 9% higher feed costs
II -- No crop program.
III -- Fifty cent per cwt. lower milk price.
IV -- No dairy price support program.
V -- Reduce income tax benefit program.
VI -- Milk supply control program.
VII -- No information technology.
VIII -- No bovine growth hormone technology

NA = not applicable

for the 52-cow Minnesota dairy compared to 74 percent under the base scenario. The equity to asset ratio would be 0.22 after ten years compared to 0.44 after ten years under the base scenario.

Eliminating income tax benefits (Scenario V) does not change the probability of survival but does adversely affect the present value of ending net worth and total debt when compared to the base.

A supply control program (Scenario VI) would increase the probability of survival from 74 percent under the base to 92 percent and the equity to asset after ten years from 0.44 to 0.55. Present value of ending net worth declines from an initial value of $417,000 to $310,000 after ten years. Total debt increases but less than under the base scenario. The supply control scenario generally is more favorable than base scenario for the 52-cow Minnesota dairy.

The probability of survival for the 52-cow Minnesota dairy would decline from 74 to 50 percent after ten years should productivity gains from information and nutrition technology not materialize (Table 16). The probability of survival without bgh declines only to 62 percent as this size dairy would adopt this technology in 1989, near the end of the ten year period.

125-cow Minnesota dairy

Given the base policy scenario, the 125-cow Minnesota dairy had a 100 percent chance of surviving ten years and a 96 percent chance of having a positive after-tax net present value (Table 17A). The present value of ending net worth increased slightly from an initial $969,000 to $1,120,000 at the end of the ten year period. Both long-term and intermediate-term debt were reduced and the equity ratio increased from an initial 0.76 to 0.89 by the end of the ten years.

Like the 52-cow Minnesota dairy, policies that increase the level or variability of feed prices have little impact on the financial performance

Table 17A. Comparison of Selected Policy Scenarios on a 125-Cow Minnesota Dairy

Criteria	Initial Situation	Alternative Scenarios*								
		Base	I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	NA	100	100	100	100	98	100	100	100	100
Probability of Positive Net Present Value (%)	NA	96	88	96	86	44	94	98	54	82
After-tax net present value mean ($1,000)	NA	369	312	369	283	59	360	461	104	235
Average present value of ending net worth ($1,000)	969	1,120	1,072	1,119	1,049	835	1,083	1,190	869	1,007
Total Debts After 10 Years ($1,000)	302	154	208	154	235	518	197	93	459	289
Average ending equity ratio (fraction)	0.76	0.89	0.86	0.89	0.85	0.67	0.87	0.93	0.70	0.81
Average internal rate of return (fraction)	NA	0.05	0.04	0.05	0.04	0.01	0.05	0.05	0.02	0.03
Average annual net farm income ($1,000)	NA	20	12	20	8	-21	3	33	-15	2

*The scenarios are:

Base -- Continuation of present policy
I -- A 20% acreage reduction crop program - 9% higher feed costs
II -- No crop program.
III -- Fifty cent per cwt. lower milk price.
IV -- No dairy price support program.
V -- Reduce income tax benefit program.
VI -- Milk supply control program.
VII -- No information technology.
VIII -- No bovine growth hormone technology

NA = not applicable

(Scenarios I and II). Because the 125-cow Minnesota dairy produces most of its own feed requirement, it is insulated from short-run variations in feed cost.

A 50 cents per cwt lower support price would reduce the present value of ending net worth from $1,120,000 under the base scenario to $1,049,000 (Scenario III). The total equity ratio would be 0.85 rather than 0.89 under the base.

No dairy support program (Scenario IV) would reduce the probability of a positive after-tax present value to 44 percent compared to 96 percent under the base scenario. Both long-term and intermediate-term debt would be $216,000 higher than under the base scenario.

Eliminating the income tax benefits (Scenario V) for the 125-cow Minnesota dairy would result in higher debts, lower present value of ending net worth, equity ratio and average annual net farm income than after ten years under the base scenario.

A supply control program (Scenario VI) would increase the probability of a positive after-tax net present value to 98 percent compared to 96 percent under the base scenario. Under both the base and supply control scenarios, the 125-cow dairy had a 100 percent chance of surviving the ten year period. The dairy showed good financial progress under the supply control program as the present value of ending net worth was $1,190,000 compared to an initial net worth of $969,000. The total equity ratio was .93 at the end of the ten year period compared to the .76 ratio at the beginning of the period. Average annual net farm income for the 10 year period was $33,000, up from $20,000 under the base.

The probability of survival would remain at 100 percent without either information or bgh technology. However, the probability of a positive net present value, average present value of ending net worth and other financial performance measures were adversly affected compared to the base.

359-cow Arizona dairy

Given the base policy scenario, the 359-cow Arizona dairy had a 96 percent chance of survival and a 96 percent change of a positive after-tax net present value for the ten year period (Table 18). The dairy showed good financial improvement over the ten years as present value of ending net worth was $1,296,000 compared to $744,000 at the beginning of the period, most debt was paid and total equity ratio increased from 0.71 to 0.93. Average annual net farm income was $14,000.

All feed is purchased by the 359-cow Arizona dairy and the 9 percent increase in feed cost (Scenario I) reduced the probability of survival to 80 percent compared to 96 percent under the base scenario. However, the dairy still made good financial progress as debts were reduced and the present value of ending net worth was $768,000 compared to the initial $744,000 at the beginning of the period. No crop programs (Scenario II) increased the variability of feed prices but reduce the financial progress of the dairy relatively little compared to the base.

A support price 50 cents below the base scenario (Scenario III) prices reduced the probability of survival compared to the base and resulted in a lower present value of ending net worth. Total equity to asset ratio still increased to 0.91, 2 percentage points under the base scenario.

Eliminating the dairy support program (Scenario IV) reduced the probability of survival to 42 percent compared to 96 percent under the base scenario. The after-tax net present value was -$326. The present value of ending net worth was $1,020,000 less than under the base and more than 60 percent lower than the $744,000 at the beginning of the period. Debt was tripled and the total equity to asset ratio decreased from 0.71 at the beginning of the period to 0.26 at the

Table 18. Comparison of Selected Policy Scenarios on a 359-Cow Arizona Dairy Farm

Criteria	Initial Situation	Alternative Scenarios[a]								
		Base	I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	NA	96	80	96	94	42	96	96	92	94
Probability of Positive Net Present Value (%)	NA	96	72	96	90	26	96	96	90	90
After-tax net present value mean ($1,000)	NA	829	172	822	593	-326	812	1,134	543	592
Average present value of ending net worth ($1,000)	744	1,296	768	1,288	1,120	276	1,247	1,486	1,028	1,107
Total Debts After 10 Years ($1,000)	298	41	254	43	72	603	42	26	82	78
Average ending equity ratio (fraction)	0.71	0.93	0.71	0.93	0.91	0.26	0.93	0.93	0.90	0.91
Average internal rate of return (fraction)	NA	0.09	0.01	0.09	0.06	-0.15	0.09	0.11	0.06	0.07
Average annual net farm income ($1,000)	NA	14	-64	13	-14	-121	6	54	-21	-19

[a] The scenarios are:
Base -- Continuation of present policy
I -- A 20% acreage reduction crop program - 9% higher feed costs
II -- No crop program.
III -- Fifty cent per cwt. lower milk price.
IV -- No dairy price support program.
V -- Reduce income tax benefit program.
VI -- Milk supply control program.
VII -- No information technology.
VIII -- No bovine growth hormone technology

NA = not applicable

end of the 10 years. Average annual net farm income was a minus $121,000 compared to $14,000 under the base.

Eliminating income tax advantages (Scenario V) slightly reduced the present value of ending net worth compared to the base scenario but had little affect on the probability of survival, remaining debt and ending total equity to asset ratio.

With supply control (Scenario VI) the probability of survival was 96 percent under the base and supply control scenarios. Present value of ending net worth was $190,000 higher at the end of the ten year period compared to the base scenario. Average annual net farm income was $54,000.

The financial progress under either the no information technology (Scenario VII) or no bgh (Scenario VIII) was somewhat less than under the base scenario that included both these technologies. The average annual net farm income became negative and the probability of survival declined from 96 to 92 percent for the no information scenario and 94 percent for the no bgh scenario.

550-cow California dairy

Given the base policy scenario, the 550-cow California dairy had a 96 percent probability of survival and positive net present value (Table 19). The dairy showed good financial improvement over the 10 year period under the base scenario. Present value of ending net worth increased from $1,261,000 at the beginning to $2,055,000 at the end of the ten year period. Total debts were greatly reduced and total equity to asset ratio increased from 0.71 to 0.92 over the ten year period.

The crop acreage reduction policy (Scenario I), resulting in a 9 percent increased feed costs, reduced the probability of survival from 96 percent under the base to 80 percent and the probability of positive after-tax net present

Table 19. Comparison of Selected Policy Scenarios on a 550-Cow California Dairy

Criteria	Initial Situation	Alternative Scenarios*								
		Base	I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	NA	96	80	96	94	62	96	96	88	94
Probability of Positive Net Present Value (%)	NA	96	58	96	88	32	96	96	80	86
After-tax net present value mean ($1,000)	NA	1,178	157	1,169	796	-292	1,157	1,682	367	659
Average present value of ending net worth ($1,000)	1,261	2,055	1,267	2,045	1,792	799	1,971	2,349	1,360	1,672
Total Debts After 10 Years ($1,000)	464	105	405	110	157	739	109	92	300	185
Average ending equity ratio (fraction)	0.71	0.92	0.73	0.92	0.90	0.52	0.93	0.92	0.81	0.89
Average internal rate of return (fraction)	NA	0.08	0.00	0.08	0.06	-0.06	0.08	0.10	0.02	0.05
Average annual net farm income ($1,000)	NA	10	-117	9	-35	-16	-5	76	-86	-57

*The scenarios are:
Base -- Continuation of present policy
I -- A 20% acreage reduction crop program - 9% higher feed costs
II -- No crop program.
III -- Fifty cent per cwt. lower milk price.
IV -- No dairy price support program.
V -- Reduce income tax benefit program.
VI -- Milk supply control program.
VII -- No information technology.
VIII -- No bovine growth hormone technology

NA = not applicable

value from 96 percent to 58 percent (Scenario I). No crop programs (Scenario II) had relatively little impact on the 550-cow California compared to the base scenario.

A milk support price 50 cents lower (Scenario III) than under the base reduced the probability of survival from 96 percent to 94 percent and the present value of ending net worth from $2,055,000 to $1,792,000. The total equity to asset ratio after ten years was .90 compared to .92 under the base scenario.

No dairy price support program (Scenario IV) reduced the probability of survival from 96 percent under the base scenario to 62 percent. The present value of ending net worth decreased to $799,000 compared to $2,055,000 under the base scenario. The total equity to asset ratio was 0.52 compared to 0.92 under the base scenario after ten years.

Eliminating income tax advantage (Scenario V) had little impact on the financial performance of the 550-cow California dairy relative to the base scenario. The total debt and total equity to asset ratio was about the same as under the base scenario.

A mandatory supply control program (Scenario VI) resulting in a milk price $1.00 per cwt higher than in the base scenario had a favorable impact on the 550-cow California dairy. Compared to the base scenario the present value of ending net worth was $2,349,000 or 14 percent higher, and the after-tax net present value was $1,682,000 or 43 percent higher than under the base scenario. The average annual net farm income increased to $76,000.

The average present value of ending net worth, equity ratio increased from the beginning of the period to the end even without the information (Scenario VII) or bgh (Scenario VIII) technology. Also total debt was reduced. However both the probability of survival and a positive net present value declined and average annual net farm income became negative.

1,436-cow California dairy

Given the base policy scenario, the 1,436-cow California dairy had a 98 percent probability of survival and showed strong financial progress from the beginning to the end of the 10 year period (Table 20). The present value of ending net worth was $7,332,000 compared to $2,538,000 at the beginning of the ten-year period. The total equity to asset ratio increase from 0.69 at the beginning of the period to 0.94 at the end. Total debt was cut by 87 percent from the beginning to the end of the period.

The acreage reduction scenario resulting in 9 percent higher feed prices reduced the probability of survival from 98 percent under the base scenario to 96 percent (Scenario I). Total equity to asset ratio was 0.92 compared to 0.94 under the base scenario.

Eliminating the crop program (Scenario II) had little impact on the financial position of the 1,436-cow California dairy. Debt, equity to asset ratio and present value of ending net worth are all about the same as under the base scenario.

A milk support price 50 cents lower (Scenario III) than under the base resulted in a 11 percent lower present value of ending net worth after ten years. Total debt increased slightly and the total equity to asset ratio remained the same as the base.

Eliminating the dairy price support program (Scenario IV) reduced the probability of survival from 98 percent under the base to 96 percent. The present value of ending net worth was $4,418,000 or 40 percent lower than under the base scenario.

Eliminating the income tax advantages (Scenario V) did not impact the probability of survival, total debt or equity to asset ratio compared

Table 20. Comparison of Selected Policy Scenarios on a 1,436-Cow California Dairy

Criteria	Initial Situation	Alternative Scenarios[a]								
		Base	I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	NA	98	96	98	98	96	98	100	96	98
Probability of Positive Net Present Value (%)	NA	98	96	98	98	92	98	100	96	98
After-tax net present value mean ($1,000)	NA	6,473	3,923	6,454	5,375	2,523	6,415	8,103	3,246	4,450
Average present value of ending net worth ($1,000)	2,538	7,332	5,477	7,316	6,509	4,418	7,142	8,543	4,648	5,747
Total Debts After 10 Years ($1,000)	1,131	145	220	148	150	307	145	96	201	145
Average ending equity ratio (fraction)	0.69	0.94	0.92	0.94	0.94	0.91	0.94	0.95	0.94	0.95
Average internal rate of return (fraction)	NA	0.15	0.08	0.16	0.15	0.07	0.16	0.19	0.10	0.12
Average annual net farm income ($1,000)	NA	449	171	447	325	7	421	653	101	207

[a] The scenarios are:
Base -- Continuation of present policy
I -- A 20% acreage reduction crop program - 9% higher feed costs
II -- No crop program.
III -- Fifty cent per cwt. lower milk price.
IV -- No dairy price support program.
V -- Reduce income tax benefit program.
VI -- Milk supply control program.
VII -- No information technology.
VIII -- No bovine growth hormone technology .

NA = not applicable

to the base scenario. However, the present value of ending net worth was decreased 2.6 percent from the base scenario.

With supply control (Scenario VI), the probability of survival of the 1,436-cow California dairy increased to 100 percent. The present value of ending net worth was $8,543,000 or about 17 percent higher under the supply control than under the base scenario. All intermediate-term debt was paid and only $96,000 of long-term debt remained after ten years under the supply control program. Average annual net farm income increased 45 percent to $653,000 compared to the base scenario.

Should the productivity gains associated with information or bgh technologies not materialize, the financial performance will be adversly affected but the probability of survival for the 1,436-cow California dairy would remain about the same. Average present value of ending net worth is 37 percent lower without information and nutrition technology (Scenario VII) and 22 percent lower without bgh technology (Scenario VIII).

Florida dairies

Given the base policy scenario the probability of survival was 98 percent for the 350-cow and 100 percent for the 600-cow and 1,436-cow Florida dairies (Tables 21, 22, and 23). Debt was reduced over the ten year period on all three size dairies. The total equity to asset ratio after ten years was at least 0.84. The present value of ending net worth increased 33 percent on the 350-cow dairy, 67 percent on the 600-cow dairy, and 177 percent on the 1,436-cow dairy.

The crop acreage reduction policy (Scenario I) reduced the probability of surviving the ten year period from 96 to 58 percent for the 350-cow

Table 21. Comparison of Selected Policy Scenarios on a 350-Cow Florida Dairy

Criteria	Initial Situation	Alternative Scenarios[a]								
		Base	I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	NA	96	58	96	86	36	94	98	86	88
Probability of Positive Net Present Value (%)	NA	88	34	88	78	28	86	96	66	78
After-tax net present value mean ($1,000)	NA	448	-185	445	235	-305	425	663	154	270
Average present value of ending net worth ($1,000)	757	1,004	463	1,002	825	317	936	1,164	706	846
Total Debts After 10 Years ($1,000)	304	198	577	198	300	679	226	130	376	287
Average ending equity ratio (fraction)	0.71	0.84	0.46	0.84	0.74	0.32	0.81	0.89	0.68	0.76
Average internal rate of return (fraction)	NA	0.07	-0.04	0.07	0.03	-0.12	0.07	0.10	0.03	0.05
Average annual net farm income ($1,000)	NA	-6	-83	-6	-31	-97	-9	25	-40	-28

[a] The scenarios are:
Base -- Continuation of present policy
I -- A 20% acreage reduction crop program - 9% higher feed costs
II -- No crop program.
III -- Fifty cent per cwt. lower milk price.
IV -- No dairy price support program.
V -- Reduce income tax benefit program.
VI -- Milk supply control program.
VII -- No information technology.
VIII -- No bovine growth hormone technology

NA = not applicable

Table 22. Comparison of Selected Policy Scenarios on a 600-Cow Florida Dairy

Criteria	Initial Situation	Alternative Scenarios[a]								
		Base	I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	NA	100	96	100	100	72	100	100	98	100
Probability of Positive Net Present Value (%)	NA	100	80	100	100	56	100	100	86	98
After-tax net present value mean ($1,000)	NA	1,617	602	1,612	1,281	85	1,576	2,011	701	1,151
Average present value of ending net worth ($1,000)	1,465	2,453	1,778	2,455	2,255	1,268	2,306	2,681	1,748	2,164
Total Debts After 10 Years ($1,000)	468	116	280	116	124	587	116	116	233	129
Average ending equity ratio (fraction)	0.76	0.94	0.86	0.94	0.94	0.66	0.94	0.93	0.89	0.94
Average internal rate of return (fraction)	NA	0.10	0.06	0.10	0.09	-0.04	0.11	0.12	0.06	0.08
Average annual net farm income ($1,000)	NA	83	-28	82	44	-97	68	137	-24	23

[a] The scenarios are:
Base -- Continuation of present policy
I -- A 20% acreage reduction crop program - 9% higher feed costs
II -- No crop program.
III -- Fifty cent per cwt. lower milk price.
IV -- No dairy price support program.
V -- Reduce income tax benefit program.
VI -- Milk supply control program.
VII -- No information technology.
VIII -- No bovine growth hormone technology

NA = not applicable

Table 23. Comparison of Selected Policy Scenarios on a 1,436-Cow Florida Dairy

Criteria	Initial Situation	Alternative Scenarios[a]								
		Base	I	II	III	IV	V	VI	VII	VIII
Probability of Survival (%)	NA	100	100	100	100	100	100	100	100	100
Probability of Positive Net Present Value (%)	NA	100	100	100	100	100	100	100	100	100
After-tax net present value mean ($1,000)	NA	8,396	6,020	8,387	7,501	4,712	8,182	9,413	5,046	6,667
Average present value of ending net worth ($1,000)	3,343	9,257	7,560	9,263	8,591	6,625	8,966	10,038	6,650	7,874
Total Debts After 10 Years ($1,000)	1,053	195	195	195	195	195	195	195	195	195
Average ending equity ratio (fraction)	0.76	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.96	0.96
Average internal rate of return (fraction)	NA	0.16	0.13	0.16	0.15	0.11	0.16	0.17	0.12	0.14
Average annual net farm income ($1,000)	NA	635	404	634	536	242	607	769	272	433

[a] The scenarios are:
Base -- Continuation of present policy
I -- A 20% acreage reduction crop program - 9% higher feed costs
II -- No crop program.
III -- Fifty cent per cwt. lower milk price.
IV -- No dairy price support program.
V -- Reduce income tax benefit program.
VI -- Milk supply control program.
VII -- No information technology.
VIII -- No bovine growth hormone technology

NA = not applicable

dairy and from 100 to 96 percent for the 600-cow dairy. The probability of survival remained at 100 percent on the large 1,436-cow Florida dairy.

Eliminating the crop program (Scenario II) had relatively little impact on all three size Florida dairies. The probability of survival remained unchanged at 100 percent for the 600-cow and 1,436-cow dairies and remained at 96 percent on the 350-cow dairy.

A milk support price 50 cents below the base (Scenario III) did not affect the probability of survival for the 1,436-cow dairy but reduced it from 96 to 86 percent for the 350-cow dairy. The present value of ending net worth was about 18 percent lower for the 350-cow dairy, 8 percent lower for the 600-cow dairy and 7 percent lower for the 1,436-cow dairy with the 50 cent lower support price compared to the base scenario.

No dairy program (Scenario IV) reduced the probability of survival from 96 to 36 percent for the 350-cow dairy and from 100 to 72 percent for the 600-cow dairy. The probability of survival remained at 100 percent for the larger 1,436-cow dairy. The present value of ending net worth was at least 28 percent less under the no dairy program scenario than under the base scenario for all three Florida dairies.

Eliminating income tax advantages (Scenario V) would have relatively little impact on all three size dairies in Florida. The present value of ending net worth was about 7 percent less for the 350-cow dairy but only 3 percent for the 1,436-cow dairy than under the base scenario. Total debt would remain the same for the 1,436-cow dairy but would be somewhat higher for the smaller dairies than under the base scenario.

A supply control policy (Scenario VI) would improve the financial position of each of the three Florida dairies. Compared to the base scenario, the present value of ending net worth would increase about 16 percent for the 350-cow dairy, 9 percent for the 600-cow dairy, and 8 percent for the 1,436-cow dairy.

Like dairies in other regions, both no information technology (Scenario VI) and no bovine growth hormone technology (Scenario VIII) adversly affected the financial position of the Florida dairies after 10 years compared to the base scenario.

Results for Financial Stress Scenarios

Minnesota dairies

Given the high debt (Scenario IX), the 52-cow Minnesota dairy had a 0 percent probability of survival over the 10 year period (Table 24). The probability of survival remained zero even with subsidized interest (Scenario X) and restructuring debt (Scenario XI). The same result was obtained for new entrant operators (Scenarios XII, XIII, and XIV).

The 125-cow Minnesota dairy in an initial high debt position had a 24 percent probability of survival (Scenario IX) (Table 25). A new entrant with high debt also had a zero probability of survival (Scenario XII). Therefore, there was a zero probability of survival under both higher feed cost (Scenario XIII) and no dairy program (Scenario XIV).

359-cow Arizona dairy

Given the high debt base (Scenario IX), the 359-cow Arizona dairy had a 66 percent probability of survival and improved its financial position from the beginning to the end of the 10 year period (Table 26). The present value of ending net worth was $709,000 compared to a $471,000 beginning net worth. Total debt was reduced $244,000 over the 10-year period. The total equity to asset ratio increased from 0.45 at the beginning of the period to 0.63 at the end.

Table 24. Comparison of Selected Policy Scenarios[a] on 52-Cow Minnesota Dairy Assuming High Debt and New Entrant.

Criteria	High Debt				New Entrants			
	Initial Situation	Scenarios			Initial Situation	Scenarios		
		IX	X	XI		XII	XIII	XIV
Probability of Survival (%)	NA	0	0	0	NA	0	0	0
Probability of Positive Net Present Value (%)	NA	0	0	0	NA	0	0	0
After-tax net present value mean ($1,000)	NA	-103	-108	-99	NA	-103	-103	-102
Average present value of ending net worth ($1,000)	246	104	96	109	264	143	144	145
Total Debts After 10 Years ($1,000)	340	423	424	419	466	505	503	504
Average ending equity ratio (fraction)	0.42	0.21	0.20	0.22	0.36	0.23	0.23	0.23
Average internal rate of return (fraction)	NA	-0.17	-0.19	-0.16	NA	-0.11	-0.10	-0.10
Average annual net farm income ($1,000)	NA	-46	-42	-44	NA	-90	-90	-91

[a] The scenarios are:
IX -- Base - continuation of present dairy policy and assuming high debt.
X -- Subsidize interest rate so effective rate on all loans is 8 percent.
XI -- Restructure debt.
XII -- Base policy and new entrant.
XIII -- New entrant and no price support for dairy.
XIV -- New entrant and a 9% increase in feed costs.

NA = not applicable

Table 25. Comparison of Selected Policy Scenarios on a 125-Cow Minnesota Dairy Assuming High Debt and New Entrant With High Debt.[a]

	High Debt				New Entrants			
		Scenarios				Scenarios		
Criteria	Initial Situation	IX	X	XI	Initial Situation	XII	XIII	XIV
Probability of Survival (%)	NA	24	16	28	NA	0	0	0
Probability of Positive Net Present Value (%)	NA	24	16	28	NA	0	0	0
After-tax net present value mean ($1,000)	NA	-80	-147	-59	NA	-237	-256	-241
Average present value of ending net worth ($1,000)	554	341	280	351	575	291	274	292
Total Debts After 10 Years ($1,000)	718	910	943	906	963	1,016	1,026	1,021
Average ending equity ratio (fraction)	0.44	0.30	0.25	0.31	0.37	0.23	0.22	0.24
Average internal rate of return (fraction)	NA	-0.06	-0.09	-0.06	NA	-0.15	-0.16	-0.16
Average annual net farm income ($1,000)	NA	-51	-58	-49	NA	-117	-121	-121

[a] The scenarios are:

IX -- Base - continuation of present dairy policy and assuming high debt.
X -- Subsidize interest rate so effective rate on all loans is 8 percent.
XI -- Restructure debt.
XII -- Base policy and new entrant.
XIII -- New entrant and no price support for dairy.
XIV -- New entrant and a 9% increase in feed costs.

NA = not applicable

Table 26. Comparison of Selected Policy Scenarios on a 359-Cow Arizona Dairy Farm Assuming High Debt and New Entrant With High Debt.[a]

	High Debt				New Entrants			
		Scenarios				Scenarios		
Criteria	Initial Situation	IX	X	XI	Initial Situation	XII	XIII	XIV
Probability of Survival (%)	NA	66	70	68	NA	52	6	16
Probability of Positive Net Present Value (%)	NA	66	70	68	NA	52	6	16
After-tax net present value mean ($1,000)	NA	417	466	440	NA	270	-320	-173
Average present value of ending net worth ($1,000)	471	709	746	730	528	583	64	217
Total Debts After 10 Years ($1,000)	570	326	297	325	715	459	787	700
Average ending equity ratio (fraction)	0.45	0.63	0.66	0.64	0.42	0.52	0.04	0.23
Average internal rate of return (fraction)	NA	0.01	0.03	0.02	NA	-0.01	-0.22	-0.08
Average annual net farm income ($1,000)	NA	-59	-46	-56	NA	-109	-191	-191

[a] The scenarios are:

IX -- Base - continuation of present dairy policy and assuming high debt.
X -- Subsidize interest rate so effective rate on all loans is 8 percent.
XI -- Restructure debt.
XII -- Base policy and new entrant.
XIII -- New entrant and no price support for dairy.
XIV -- New entrant and a 9% increase in feed costs.

NA = not applicable

Restructuring debt (Scenario XI) increased the probability of survival from 66 to 70 percent and improved the present value of ending net worth and equity to asset ratio compared to the high debt base (Scenario IX).

A new entrant with high debt had a 52 percent probability to survive over the 10 year period (Scenario XII). A new entrant under no dairy price support program (Scenario XIII) had only a 6 percent probability of survival. Increased feed costs (Scenario XIV) decreased a new entrants probability of survival from 52 to 16 percent.

350-cow Florida dairy

Given the high debt base (Scenario IX), the 350-cow Florida dairy had only a 34 percent probability of survival (Table 27). Present value of ending net worth was $375,000 compared to a beginning net worth of $466,000. The total equity to asset ratio decreased from 0.44 at the beginning to 0.38 at the end of the 10-year period.

The interest subsidy (Scenario X) increased the probability of survival from 38 percent to 42 percent and increased the present value of ending net worth from $375,000 to $382,000 compared to the high debt base (Scenario IX). The debt restructuring policy (Scenario XI) improved present value of ending net worth for the 350-cow Florida dairy compared to the high debt base (Scenario IX). However, the improvement was considerably less than under the interest subsidy.

A new entrant with high debt had only a 22 percent probability of survival (Scenario XII). The probability of survival declined to 2 percent with 9 percent higher feed cost (Scenario XIII). No dairy price support program reduced the probability of a new entrant and high debt dairy surviving from 22 to 2 percent (Scenario XIV).

Table 27. Comparison of Selected Policy Scenarios on a 350-Cow Florida Dairy Assuming High Debt and New Entrant With High Debt.[a]

Criteria	High Debt				New Entrants			
	Initial Situation	Scenarios			Initial Situation	Scenarios		
		IX	X	XI		XII	XIII	XIV
Probability of Survival (%)	NA	34	38	36	NA	22	2	2
Probability of Positive Net Present Value (%)	NA	34	38	36	NA	22	2	2
After-tax net present value mean ($1,000)	NA	6	26	23	NA	-75	-297	-263
Average present value of ending net worth ($1,000)	466	375	382	392	527	326	116	181
Total Debts After 10 Years ($1,000)	594	609	609	602	773	741	897	897
Average ending equity ratio (fraction)	0.44	0.38	0.39	0.39	0.41	0.31	0.10	0.17
Average internal rate of return (fraction)	NA	-0.05	-0.04	-0.04	NA	-0.05	-0.22	-0.03
Average annual net farm income ($1,000)	NA	-88	-76	-85	NA	-155	-194	-211

[a] The scenarios are:
IX -- Base - continuation of present dairy policy and assuming high debt.
X -- Subsidize interest rate so effective rate on all loans is 8 percent.
XI -- Restructure debt.
XII -- Base policy and new entrant.
XIII -- New entrant and no price support for dairy.
XIV -- New entrant and a 9% increase in feed costs.

NA = not applicable